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AIRCRAFT MAINTENANCE EXPERIENCE DESIGN HANDBOOK

VOUGHT CORPORATION
DALLAS, TEXAS

SEPTEMBER 1978

Prepared for

MAINTENANCE POLICY AND ENGINEERING DIVISION
Naval Air Systems Command
Washington, D. C. 20361

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The Aircraft Maintenance Experience Design Handbook was developed for the Maintenance Policy and Engineering Division of the Naval Air Systems Command. This Handbook presents guideline procedures for evaluating new aircraft quantitative maintainability parameters, establishing weapon system requirements and analyzing component designs. (OVER)

The Aircraft Maintenance Experience Design Handbook is organized into

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The procedures are presented in a sequence to permit analysis for the total aircraft, or down to aircraft system or component level. Design and maintenance engineers can use this information for analyzing new systems and components or those being considered for change.

ABSTRACT

The *Aircraft Maintenance Experience Design Handbook* was developed for the Maintenance Policy and Engineering Division of the Naval Air Systems Command. This Handbook presents guideline procedures for evaluating new aircraft quantitative maintainability parameters, establishing weapon system requirements and analyzing component designs.

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PREFACE

This report was prepared by Vought Corporation, Maintainability Engineering Group, Logistics Engineering Section, Dallas, Texas. The project was conducted under contracts N00140-76-C-0025 and N00140-77-C-0091 and was monitored by the Naval Air Systems Command, Aircraft Structures and Equipment Branch, AIR-4114, with Mr. George J. Donovan, as coordinator.

AIRCRAFT
MAINTENANCE EXPERIENCE
DESIGN HANDBOOK

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ILLUSTRATIONS AND TABLES

Separate listings of the Illustrations and Tables contained in the Handbook are not provided due to the repetitive nature of the titles and the voluminous extent of the individual listings. To insure completeness of the text, the inclusive numbers for each section are included. With one exception, (Section 5.0), they are numbered sequentially within each section and all numbers are prefixed with the section or appendix identifier in which they appear.

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AIRCRAFT MAINTENANCE EXPERIENCE DESIGN HANDBOOK

1.0 INTRODUCTION AND SUMMARY

The Aircraft Maintenance Experience Design Handbook was developed for the Maintenance Policy and Engineering Division of the Naval Air Systems Command. The Handbook presents guideline procedures for evaluating new aircraft quantitative maintainability parameters, establishing weapon system requirements and analyzing component designs.

The Aircraft Maintenance Experience Design Handbook is organized into three parts. Parts I and II address maintenance at both the Organizational and Intermediate levels while Part III primarily discusses component installations at the Organizational level. Part I contains a description of the technical analysis leading to the development of the Maintainability Index Model (MIM). Part II provides the instructions for the application of the model for establishing maintainability requirements and evaluating maintainability predictions. Part II also provides maintainability data on various aircraft and their systems which will aid the user in making procedure adjustments for special aircraft applications. Part III presents quantitative and qualitative information concerning the maintainability attributes of selected maintenance significant component installations. Those installation characteristics that have proven to be effective in expediting or simplifying maintenance are highlighted.

The procedures are presented in a sequence to permit analysis for the total aircraft, or down to aircraft system or component level. Design and maintenance engineers can use this information for analyzing new systems and components or those being considered for change.

PART I. DEVELOPMENT OF THE MAINTAINABILITY INDEX MODEL - A TECHNICAL ANALYSIS

Section 2.0 presents a supplemental procedure to the 3-M Maintenance Data Reporting System (Reference 18) converting Fleet reported data into a "design-to" equivalent. A standard data reduction procedure is presented for reducing raw 3-M data tapes into three classes of maintenance. This was done to identify specific maintenance actions and time as either the responsibility of the contractor that can be controlled through design or the responsibility of the Navy that cannot be controlled through design. A computer routine was used to establish the three classes. Class 1 identifies all Fleet reported maintenance. Class 2 is an intermediate step to eliminate Navy responsible maintenance actions. Class 3 identifies "design-to" maintenance achieved by eliminating Navy controllable maintenance time from Class 2 maintenance. This was accomplished using data from the A-7A and F-14A maintainability demonstrations which showed that a mathematical relationship exists between maintenance time documented by technicians and maintenance time measured by monitors. Thus, this section validates the need to adjust maintainability parameters by screening maintenance actions and maintenance time.

Section 3.0 describes the derivation of the Maintainability Index Model which shows that the maintainability characteristics of tactical Fighter/Attack/ASW aircraft are directly related to design and performance parameters and as the physical size, performance and capability of a weapon system varies,

so does its maintenance requirements. Measurement of this relationship is achieved through use of a Maintainability Index Model.

PART II. MAINTAINABILITY INDEX MODEL APPLICATION INSTRUCTIONS

Section 4.0 presents a set of weapon system Maintenance Manhours per Flight Hour (MMH/FH) conversion charts that allow the user to convert fleet reported 3-M data (Class 1) to a "design-to" equivalent (Class 3). The total aircraft MMH/FH conversion chart shows that an increase in "design-to" maintenance is magnified by a factor of approximately 2.5 in the operational environment. These charts can be used to establish new aircraft MMH/FH requirements at the weapon system level.

Section 5.0 provides a procedure for evaluating contractor quantitative maintainability predictions at the system level using the Maintainability Index Model. Techniques presented in this section can also be used by the Navy to establish system goals based on operational/mission profile and desired technology improvements.

The model is presented at system level to conform to the usual responses to RFPs (Request for Proposal) which are normally restricted to this level because of the lack of detail design data. The primary output from the model is displayed graphically for each system. Completion of the system worksheet and plotting selected results on the graphs enables the user to evaluate the contractor predictions for a new system. The difference between model baseline data and the contractor's prediction reflects the net maintainability improvement or degradation over the established (state-of-the-art) design.

A secondary use of the model is to aid in establishing new weapon system requirements and system goals. Prior to the release of the RFP, operational/mission profile data can be input to the model. Maintenance Index (MMH/FH) system graphs can be solved yielding baseline state-of-the-art values. The addition of a desired percentage improvement over the baseline design will provide system goals for the new procurement. Summation of the system goals can be used to establish total weapon system requirements.

PART III. EVALUATION AND ANALYSIS OF SELECTED COMPONENT INSTALLATIONS

Section 6.0 presents an analysis of the relationship that design and installation traits have on maintenance as experienced by the Fleet for selected maintenance significant components. After component identification, which was based on maintenance frequency and manhour consumption, functionally similar components were qualitatively and quantitatively evaluated on all nine aircraft, allowing a comparison of both good and bad design features to be made. These evaluations were based on what must be done to remove, replace, and functionally check the item, i.e., how good was a particular design in facilitating maintenance and how good was the product maintainability? Evaluations were made without regard to cost, weight or acknowledged maintainability compromises, and therefore are representations of ideal maintainability.

Each of the functional component analyses has three sheets of data provided. The first is a tabular display of the 3-M maintenance data each aircraft experienced during the selected time frame for the Work Unit Code (WUC) listed. The second is a graphical presentation of several parameters deemed the most

significant in describing the maintainability and maintenance costs of a component. The third is a discussion of how the peculiar design traits of the component impact Organizational level maintenance. Emphasis is placed on Remove and Replace (R+R) time as the "purest" measure of installation design effectiveness. Recommendations are made to aid in establishing maintainability criteria for application prior to component and weapon system design. This portion of the Aircraft Maintenance Experience Design Handbook should be used in conjunction with the Qualitative Maintenance Experience Handbook prepared for the Maintenance Policy and Engineering Division, 20 October 1975. This Handbook contains qualitative information on component installations on the same aircraft found in this text. A P-3C/S-3A supplement to the Qualitative Maintenance Experience Handbook was prepared in August, 1977 and also should be used with the Design Handbook.

1.1 DATA DERIVATION

Baseline maintenance data used in this Handbook was derived from the Navy Maintenance, Management and Material (3-M) System. The majority of the data used in Section 6.0 was obtained from the Naval Aviation Logistics Center (NALC) through the use of their ASMRA (Adjustment of Scheduled Maintenance Requirements through Analysis) programs. Additional data, used primarily for development of the two-digit system Maintainability Index Model, and flight hours for the time period covered were obtained from the Navy Fleet Maintenance Support Office (FMSO) via raw 3-M data tapes and the Fleet Weapon System Reliability and Maintainability Statistical (RAMS) Summary Report.

A list of references and a list of abbreviations and acronyms are provided to enhance the readability of the Handbook. Appendix A is a data summary and Appendix B is a Standard Work Unit Code (SWUC) Matrix, both taken from FMSO data on the eight aircraft analyzed in Section 5.0 of the Handbook. These aircraft are the A-4, F-4, A-6, A-7, F-8, AV-8, F-14 and S-3. Appendix C summarizes a special study on the mathematical relationship between reported and measured maintenance task time on A-7A and F-14A aircraft. Appendix D presents the background of data used in Section 6.0 in the Handbook. Appendix E presents a study on some of the factors that effect MMH/FH during the life cycle of the aircraft.

Any questions concerning the use or derivation of information contained in this Handbook should be directed to the Aircraft Structures and Equipment Branch, Maintenance Policy and Engineering Division, Naval Air Systems Command, Washington, D.C., 20361.

PART I

DEVELOPMENT OF THE MAINTAINABILITY INDEX MODEL - A TECHNICAL ANALYSIS

2.0 CLASSIFICATION OF MAINTENANCE DATA

Part I of the Handbook presents a discussion on the development of the Maintainability Index Model (MIM). The MIM is the tool used to provide baseline maintenance requirements as a function of design constraints. Supporting documentation that follows is based on the assumption that the elemental activities for a new system will closely resemble the systems for which data was collected. Mathematics has been kept to a minimum, stressing simplicity in calculations and evaluation procedures. The end product is an estimating technique relying heavily on past experience but still responsive to new design technology improvements.

The fundamental problem in developing a procedure for predicting and evaluating new aircraft maintenance requirements was to provide a standard criteria of measurement acceptable to both the Navy and the contractor. The approach taken in this Handbook was to use the 3-M Maintenance Data Reporting (MDR) System (Reference 18) as a data source and develop a supplemental procedure which converts reported 3-M data into a "design-to" equivalent and vice-versa. Steps necessary to accomplish this include:

- o Discussion of 3-M data as a data source for evaluating contractual requirements.
- o Identification of three classes of maintenance to aid in data analysis and a discussion of pertinent maintenance actions and maintenance time that can be controlled through design.

2.1 THE 3-M MAINTENANCE DATA REPORTING SYSTEM

Proper evaluation of aircraft maintenance data requires that attention be given to the type of data being analyzed. It is generally recognized that there are differences between a contractor's predicted quantitative maintenance data, the maintenance data which is subsequently generated during a demonstration and the data which the equipment user reports from operational experience. To insure traceability between the various types of data generated, a standard criteria of measurement had to be established to span the complete program cycle. Predictions developed during conceptual, development and design phases must be validated during test and operational phases (Reference 13). Standard terminology and approaches are required to insure "design-to" estimates relate to "real world" data. It is important to avoid the problem of meeting contractual specification requirements but not achieving operational expectations.

The primary requirement in analyzing data is first, an understanding of what is included in the data and second, what is the data to be used for. It is necessary to know whether all maintenance actions and the associated times reported on MDR forms (Reference 18) are included in the data or are certain actions and times deleted. Furthermore, is the data going to be used to evaluate a new aircraft design in a "real world" operating environment (Reference 9) or under controlled demonstration conditions where incentives and penalties are involved (Reference 1 and 20)?

Just as aircraft weight can be classified into specific categories, i.e. empty, gross, clean, design, landing, so can aircraft maintenance. Using "weights" terminology as a guide, Figure 2.2 shows how the three classes of maintenance were established.

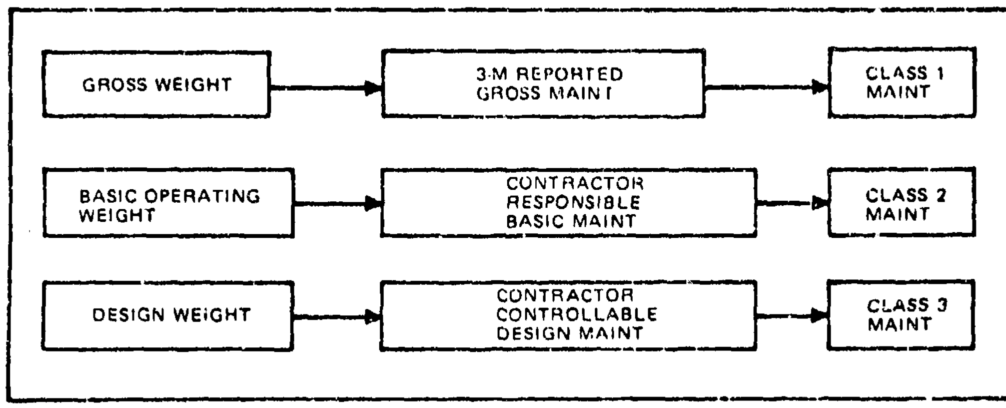


Figure 2.2 Weight/Maintenance Terminology

The definitions that follow were based on a thorough analysis of the 3-M MDR System. Table 2.1 expands on these definitions by listing specific 3-M data codes included and excluded for each class of maintenance.

Class 1 3-M Reported Gross Maintenance is defined as that effort expended by assigned personnel in the actual performance of maintenance and support tasks as documented on MDR forms VIDS/MAF and SAF. (Visual Information Display System/Maintenance Action Form and Support Action Form.) Tasks include all unscheduled, scheduled and support actions identified by Support Action Codes 01 through 09 and system codes 11 through 97.

Class 2 Contractor Responsible Basic Maintenance is defined as that element of Class 1 maintenance that identifies only those maintenance actions a contractor has control over through a Maintainability (M) program plus the respective maintenance time as documented on the VIDS/MAF and SAF. Tasks include servicing, troubleshooting launch aircraft, corrosion prevention, inspections and unscheduled maintenance actions but excludes operational support, shop support, cannibalization, improper maintenance actions, and other no defect related actions. Class 2 maintenance is an intermediate step necessary in the data reduction process that eliminates Navy responsible maintenance actions.

Class 3 Contractor Controllable Design Maintenance is defined as that portion of Class 2 maintenance that identifies the inherent maintenance actions and maintenance time a contractor can control through the design of a weapon system. Tasks include all Class 2 maintenance actions adjusted for contractor controllable maintenance time as determined from A-7A/F-14A maintainability demonstration results. Contractor controllable time is defined as the actual work within the designated work area. It includes preparation, access, fault isolation, fault correction, adjustment/calibration, checkout and cleanup, but excludes travel to and from a job, minor maintenance delays, filling out forms and any other activity inherently associated with delay time.

The 3-M Maintenance Data Reporting System was developed to report aircraft maintenance expenditures. It was not intended to provide "design-to" data to evaluate the inherent maintainability characteristics of a weapon system. However, a conversion between reported 3-M data and equivalent "design-to" data is possible through selected data reduction techniques. The technique used in this Handbook was the establishment of classes of maintenance.

2.2 THREE CLASSES OF MAINTENANCE

The Aircraft Maintenance Experience Design Handbook presents a standard data reduction procedure for reducing raw 3-M data into three classes of maintenance. These classes of maintenance identify specific maintenance actions and the documented maintenance time which are either the responsibility of the contractor and as such can be controlled through design or they are the responsibility of the Navy and cannot be controlled through design. Figure 2.1 shows a logic flow diagram depicting the separation of reported data into three classes. A discussion on terminology, definitions and rationale follows.

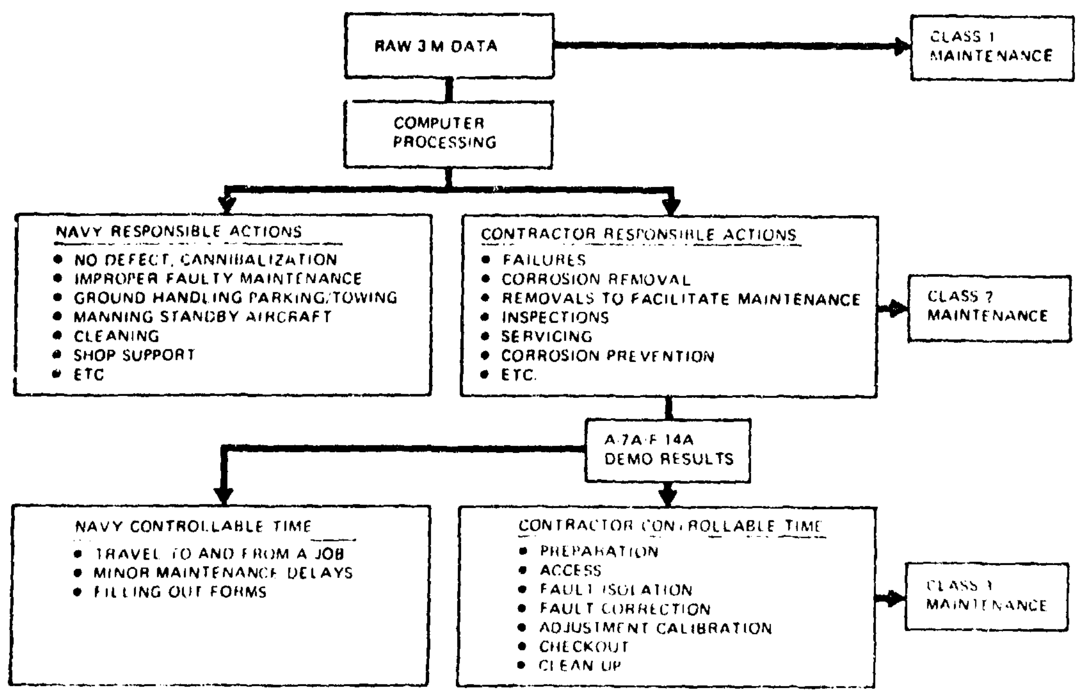


Figure 2.1 Three Classes of Maintenance Logic Flow Diagram

TABLE 2.1 THE 3-M DATA REDUCTION PROCEDURE

CLASS OF MAINT	SYSTEM/TASK	STD WUC	TYPE MAINT CODE	REMARKS
1	UNSCHEDULED MAINTENANCE • Airframe/Fuselage • Landing Gear • Flight Controls • • • • • Miscellaneous Systems	 11, 12 13 14 • • • • 90	ALL	Includes all maintenance/support actions and time as reported in references (9) and (15) and documented on the VIDS/MAF or SAF for card codes 01, 11 21 and 31 over a given time period.
	SCHEDULED MAINTENANCE • Inspections	 03	ALL	
	SUPPORT • Operational Support • Cleaning • Corrosion Prevention • Shop Support	 01 02 04 05	ALL	
2	UNSCHEDULED MAINTENANCE • Airframe/Fuselage • Landing Gear • Flight Controls • • • • • Miscellaneous Systems	 11, 12 13 14 • • • • 90	ALL	Excludes the following no defect, cannibalization, improper/faulty maint, FOD malfunction codes 030, 086, 087 092, 093, 106, 108, 158, 246, 301, 303, 304, 311, 424, 437, 440, 697, 698, 731, 758, 799, 801, 805, 807, 877, 878, 931.
	SCHEDULED MAINTENANCE • Turnaround/Preflight • Daily/Special • Phase • Conditional	 03C 03D 03G 03S	 C D G, P, Q S	Excludes inspection codes 03E (acceptance/transfer), 03F (transient) and all other inspection codes with type maintenance codes A, B, H, L, R, T, U.
	SUPPORT • Servicing • Troubleshoot Launch A/C • Corrosion Prevention	 012 016 04	 A A A	Excludes support action codes: 010 (operational support), 011 (ground handling), 013 (mission configuration), 014 (ground safety), 015 (manning standby aircraft), 017 (Inertial Navigation System), 018 (FOD walkdown), 019 (other), 02 (cleaning); 05, 06, 07, 08 and 09 (shop support).
3	SAME AS CLASS 2			Excludes inherent 3-M delay time from class 2 maintenance that is reported on the VIDS/MAF or SAF but is not controllable through design, i.e. travel to and from a job, minor maintenance delays, filling out forms, etc. Values determined through equations listed in Figure 2-4.

Definitions presented for the three classes of maintenance address aircraft maintenance at the weapon system level which includes scheduled and unscheduled maintenance as well as support actions. Scheduled maintenance and support actions will be treated in Section 4.0 with application to total weapon system maintenance. The remainder of the Handbook will address unscheduled maintenance as it relates to aircraft systems and components.

A logic flow diagram is presented in Figure 2.3 showing the 3-M data reduction procedure used in establishing the three classes of unscheduled maintenance. Rationale is presented in the next two paragraphs explaining why certain maintenance actions and maintenance time are excluded in the above definitions.

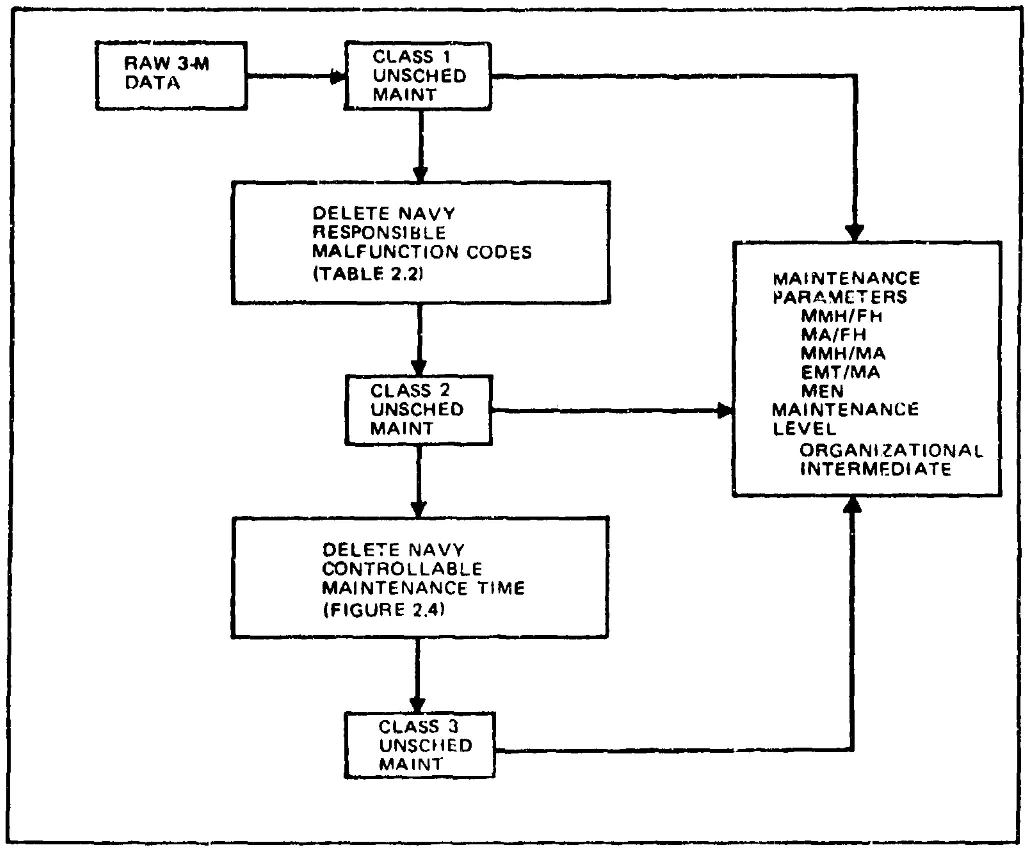


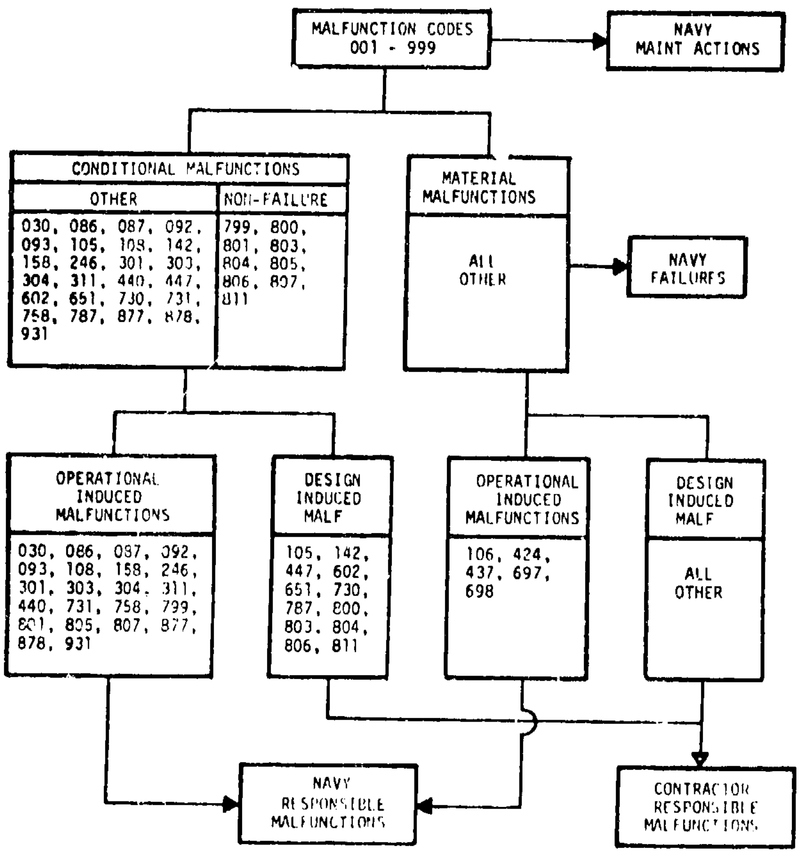
Figure 2.3 Classification of Unscheduled Maintenance

2.2.1 Maintenance Actions

OPNAVINST 4790.2A, Volume III, Appendix E (Reference 18) lists equipment Malfunction Codes used on the VIDS/MAF for identifying unscheduled maintenance actions. These codes are broken down into two categories: material and conditional. Material Malfunction Codes describe the Navy definition of a failure provided certain Action Taken Codes and other levels of data censorship are met (Reference 9). Conditional Malfunction Codes identify a malfunction due to an induced condition rather than an internal failure of the item. Both categories address malfunctions only from the standpoint of Navy operations. Two addi-

tional categories are needed to identify Malfunction Codes applicable to contractor considerations. They are (1) design induced malfunctions and (2) operational induced malfunctions. Table 2.2 lists malfunction codes by category. (Word descriptions of the codes may be found in Appendix D, Table D-1.)

TABLE 2.2 DISTRIBUTION OF NAVY MALFUNCTION CODES



Design Induced Malfunction (DIM) Codes identify malfunctions a contractor has influence over through a maintainability program. These malfunctions are primarily caused by limitations of a design whether intentional (forced removals) or unintentional (design deficiencies). Operational Induced Malfunction (OIM) Codes identify certain material and conditional malfunctions that are induced through personnel error or result from outside influences, i.e. improper maintenance, foreign object damage, cannibalization, and other no defect related actions. Maintenance actions resulting from these malfunctions should not be charged to the contractor during a demonstration.

It is recognized that not every DIM code reported on the VIDS/MAF is attributed to a design deficiency nor is every OIM code the result of improper mainte-

nance. Limitations exist in all data systems that use 100% reporting by technicians assigned to perform and document maintenance. However, this procedure presents a significant step in separating contractor responsible maintenance actions from the total reported maintenance actions. The net result is a procedure that provides data traceability and a basis for making comparisons between aircraft.

Applying these ground rules to the eight aircraft used in the two-digit analysis (Section 5.0), results show that only two-thirds (68%) of the Class 1 Organizational level maintenance actions expressed in terms of MA/FH (Maintenance Actions per Flight Hour) are the result of Design Induced Malfunctions (Class 2). At the Intermediate level, this value is 82%. It is concluded that 3-M maintenance actions must be screened if they are to be used to evaluate maintainability.

2.2.2 Maintenance Time

Appendix C summarizes a Vought study on the A-7A and F-14A Maintainability Demonstrations. Conclusions drawn from this study indicate that a mathematical relationship exists between maintenance time reported by technicians in a 3-M environment and maintenance time measured by monitors in a Fleet Supportability Evaluation (FSE)/demonstration environment. This relationship is expressed by a set of equations developed through regression analysis techniques, Figure 2.4.

PARAMETER	ML	EQUATION
MMH/MA	O	$Y_1 = 0.1966 + 0.5797\ (X_1)$
EMT/MA	O	$Y_2 = 0.2126 + 0.5170\ (X_2)$
MMH/MA	I	$Y_3 = 0.3026 + 0.6215\ (X_3)$
EMT/MA	I	$Y_4 = 0.1606 + 0.6497\ (X_4)$

WHERE, X = CLASS 2 MAINTENANCE TIME
Y = CLASS 3 MAINTENANCE TIME
X – Y = NAVY CONTROLLABLE MAINT. TIME

Figure 2.4 Reported — Versus — Measured Time Relationships

Applying this relationship to the eight aircraft used in the two-digit analysis shows that only 62% of the Class 2 Organizational level maintenance time expressed in MMH/MA (Maintenance Manhour per Maintenance Action) is attributed to the inherent maintainability of the aircraft and as such is contractor controllable (Class 3). The remaining 38% is attributed to inherent 3-M delay time i.e., travel to and from the job, filling out forms, and other causes of minor maintenance delays, and as such is Navy controllable.

Combining MA/FH with MMH/MA results in 46% of the Class 1 O-level unscheduled MMH/FH attributed as contractor controllable (Class 3). At I-level, this value is 58%. The discussion in this section shows the need to screen maintenance actions and adjust maintenance time when evaluating maintainability.

3.0 MAINTAINABILITY INDEX MODEL (MIM)

The prediction tool used to determine two-digit WUC maintenance values involves the use of a Maintainability Index Model (MIM). The MIM projects realistic maintainability estimates for Navy Fighter, Attack and ASW aircraft for use during conceptual and development design. The model is based on regression analysis techniques which relate historical maintenance data (MMH/FH and MA/FH) to design and performance parameters, i.e. weight, thrust, speed, etc. This technique was used successfully by the Northrop Corporation in a report on maintenance characteristics of United States Air Force tactical fighter aircraft (Reference 11). Techniques from that study were modified and expanded to include additional maintenance data. The result is that the MIM and its complete set of index equations provides the Navy with a unique capability to rapidly evaluate and predict new aircraft maintenance requirements.

3.1 GENERAL DESCRIPTION

This section discusses the procedure used to predict MMH/FH, MA/FH, MMH/MA, EMT/MA and MEN at Organizational ("O") and Intermediate ("I") levels for a 3-M (Class 1) and FSE (Class 3) environment. A logic flow diagram depicting the derivation and operation of the MIM is presented in Figure 3.1. Section 3.0 also contains sample calculations and model validation.

3.2 MODEL DERIVATION

The maintainability characteristics of tactical fighter/attack aircraft are directly related to design and performance parameters (Reference 10). Selection of these parameters along with a valid maintenance data base was the first step in developing the MIM.

3.2.1 Aircraft Parameters

It is recognized that increased performance of modern aircraft results in increased maintenance requirements. Although the increase in maintenance is probably due to increasing system complexity, accurate measure of complexity is difficult to derive and to apply consistently. Through considerable research and trial and error, a viable procedure which can accurately and consistently measure system complexity was developed. This procedure, which is used in this text, involves the use of design and performance parameters to establish a relationship between increases in complexity and maintenance requirements.

The Fighter/Attack/ASW aircraft considered in the correlation analysis were chosen because they provided a broad historical data base. Availability of maintenance data and design parameters were the main factors in the selection of these late model aircraft. Listed below are the aircraft used in the two-digit WUC analysis by type aircraft and year of first Fleet delivery:

A-4M	1971	F-4J	1966
A-6E	1971	F-8J	1968
A-7E	1969	F-14A	1973
AV-8A	1971	S-3A	1974

These aircraft possess the range and variation of design characteristics necessary to produce valid estimating relationships. The empty weight of the

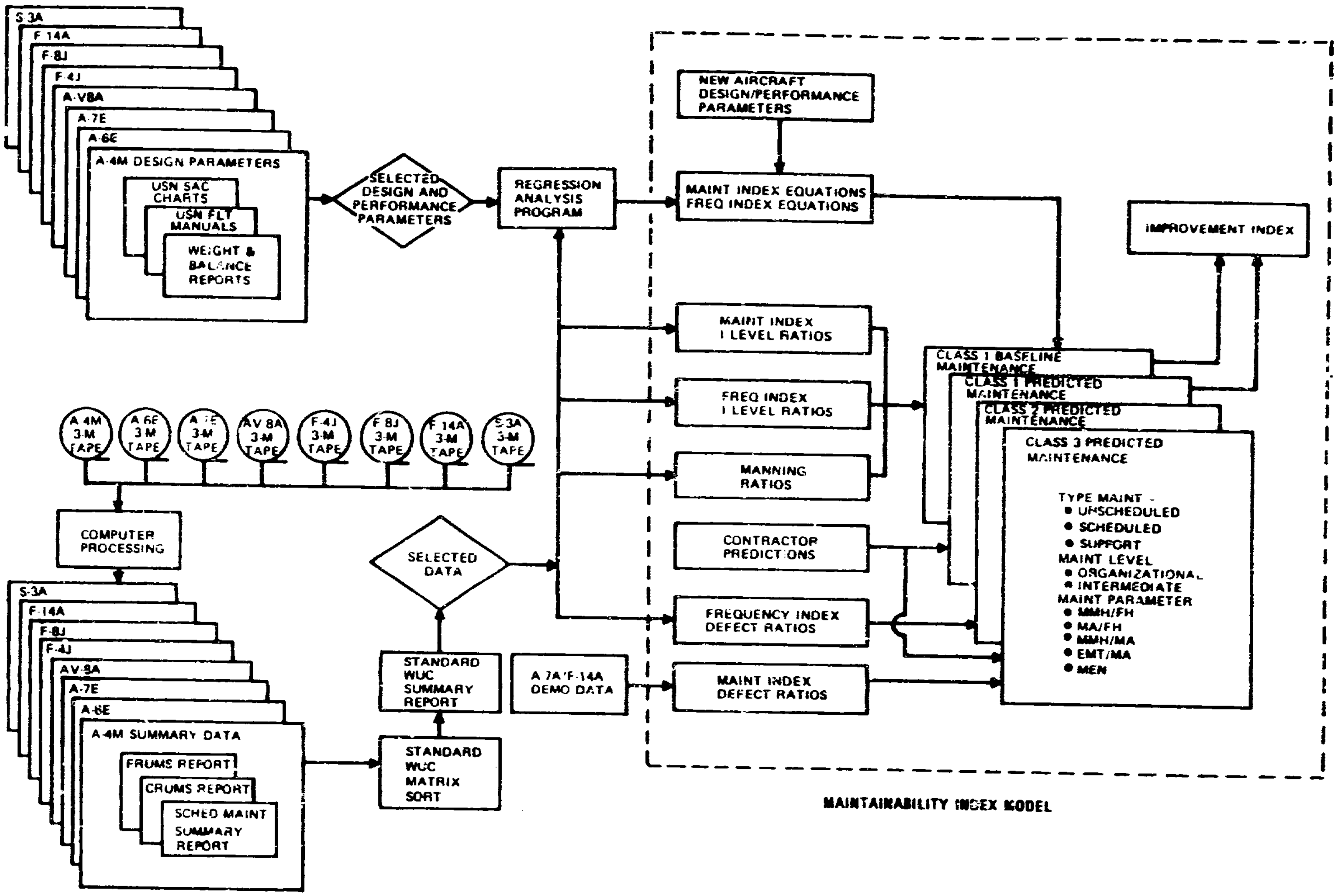


Figure 3.1 Navy Maintainability Index Model Logic Flow Diagram

aircraft range from 10,400 pounds to 38,200 pounds; the maximum speed ranges from 400 to 1300 knots and thrust ranges from 11,200 pounds to 41,800 pounds. Selected aircraft are evenly distributed with respect to crew size (four single-seat, three two-seat and one four-seat) and number of engines (four single-engine and four twin engine).

Table 3.1 presents a list of those parameters that were found to be most representative of an aircraft's design characteristics and were proven to be statistically valid. Values shown were extracted from the following documents:

- o USN Standard Aircraft Characteristics Charts
- o Weight and Balance Reports generated by each contractor

Other aircraft parameters that were considered, but rejected by the regression analysis program because of poor correlation include:

- o Weight, Environment Control System (ECS)
- o Weight, Engine
- o Speed, Minimum Landing
- o Thrust per Aircraft
- o Number of Fuel Tanks
- o Fuselage Volume
- o Service Ceiling
- o Maximum Payload
- o Utilization Rate
- o Weight, Useful Load

3.2.2 Two-Digit Work Unit Code (WUC) Data Base

A 4 to 12 month FMSO data base was selected for use in the system analysis. Raw 3-M data tapes obtained from FMSO were processed by computer programs into four output reports: three concerning unscheduled maintenance and one concerning scheduled maintenance. Each of the three unscheduled reports identified one of the three classes of maintenance established in the previous section, paragraph 2.3. The scheduled report identified scheduled maintenance for the three classes of maintenance in one report.

- o <u>FRUMS Report</u>. The Fleet Reported Unscheduled Maintenance Summary (FRUMS) Report depicted Class 1 maintenance. It identified historical maintenance data as reported in an operational environment.

- o <u>CRUMS Report</u>. The Contractor Responsible Unscheduled Maintenance Summary (CRUMS) Report was derived from the FRUMS Report with Navy responsible malfunctions (Table 2.2) deleted. CRUMS data depicted Class 2 maintenance.

- o <u>CCUMS Report</u>. The Contractor Controllable Unscheduled Maintenance Summary (CCUMS) Report was derived from the CRUMS Report with Navy controllable maintenance time (Figure 2.4) deleted. CCUMS data depicted Class 3 maintenance.

- o <u>SCHED Report</u>. The Scheduled Maintenance Summary Report was derived from the raw 3-M data tapes. It identified scheduled maintenance and support by all three classes of maintenance.

TABLE 3.1 DESIGN CHARACTERISTICS – NAVY FIGHTER/ATTACK/ASW AIRCRAFT

AIRCRAFT PARAMETER	SYMBOL	UNITS	A-4M	A-6E	A-7E	AV-8A	F-4J	F-8J	F-14A	S-3A
AREA, WING	WAREA	10^3 FT^2	0.260	0.529	0.375	0.201	0.530	0.375	0.565	0.598
AUXILIARY POWER UNIT*	KAPU	1	1	0	0	1	0	0	0	1
BOUNDARY LAYER CONTROL*	KBLC	1	0	0	0	0	1	1	0	0
CREW SIZE	CREW	1	1	2	1	1	2	1	2	4
DRAG CHUTE*	KCHUTE	1	1	0	0	0	1	0	0	0
FUEL CAPACITY, INTERNAL	FUEL	10^3 GALS	0.800	2.344	1.476	0.758	1.998	1.348	2.382	1.933
GENERATOR ELECTRICAL POWER	GENKVA	10^2 KVA	0.200	0.600	0.250	0.120	0.600	0.250	1.200	1.500
GUN FACTOR*	KGUN	1	1	0	1	1	0	1	1	0
KINETIC ENERGY (WTLAND X VMIN^2)	KE	10^9 LB-KT^2	0.209	0.347	0.408	NA	0.656	0.380	0.664	0.260
LENGTH, FUSELAGE	FUSLEN	10^2 FT	0.413	0.547	0.461	0.455	0.581	0.545	0.619	0.533
NUMBER OF ENGINES	ENGQTY	1	1	2	1	1	2	1	2	2
NUMBER OF PYLONS	PYLQTY	1	5	5	8	5	9	4	6	2
SPEED, MAX AT ALTITUDE	VMAX	10^3 KNOTS	0.537	0.490	0.506	0.525	1.230	0.989	1.314	0.410
SPEED, MIN CARRIER APPROACH	VMIN	10^3 KNOTS	0.130	0.110	0.139	–	0.136	0.130	0.122	0.095
THRUST PER ENGINE, UNINSTALLED	THRUST	10^3 LBS	11.2	9.3	15.0	20.9	17.9	19.6	20.9	9.275
WEIGHT, AVIONICS INSTALLED	WTAVIN	10^3 LBS	0.612	2.329	1.347	0.590	2.641	0.819	3.039	4.223
WEIGHT, AVIONICS UNINSTALLED	WTAVUN	10^3 LBS	0.517	1.920	1.185	0.460	1.669	0.711	2.422	3.240
WEIGHT, COMBAT	WTCOM	10^3 LBS	17.6	45.5	25.9	19.5	41.7	26.8	49.5	38.2
WEIGHT, EMPTY	WTMT	10^3 LBS	10.4	26.0	18.9	12.0	30.8	19.8	38.2	26.6
WEIGHT, LANDING CLEAN	WTLAND	10^3 LBS	12.4	28.7	21.1	13.0	35.5	22.5	44.6	28.9
WEIGHT, MAX TAKE-OFF	WTMXTO	10^3 LBS	24.5	60.4	42.0	24.6	56.0	34.0	72.5	52.5
WING SWEEP	KWING	1	0	0	0	0	0	0	1	0

* 1 IF APPLICABLE, 0 IS NOT.

Data from these reports were put into a Standard WUC Matrix (Appendix B) and programmed into a Standard WUC Summary Report (Appendix A). Identification of the time frame for the FMSO data base by type aircraft and corresponding flight hours is presented in Table 3.2.

TABLE 3.2 FMSO DATA BASE

AIRCRAFT	TIME PERIOD	MONTHS	FLT HRS
A-4M	DEC 75 - MAR 76	4	7,160
A-6E	DEC 75 - MAR 76	4	19,802
A-7E	JAN 75 - DEC 75	12	106,225
AV-8A	DEC 75 - MAR 76	4	5,944
F-4J	DEC 75 - MAR 76	4	26,238
F-8J	JAN 73 - AUG 73	8	14,087
F-14A	DEC 75 - APR 76	5	12,133
S-3A	JAN 75 - DEC 75	12	22,820

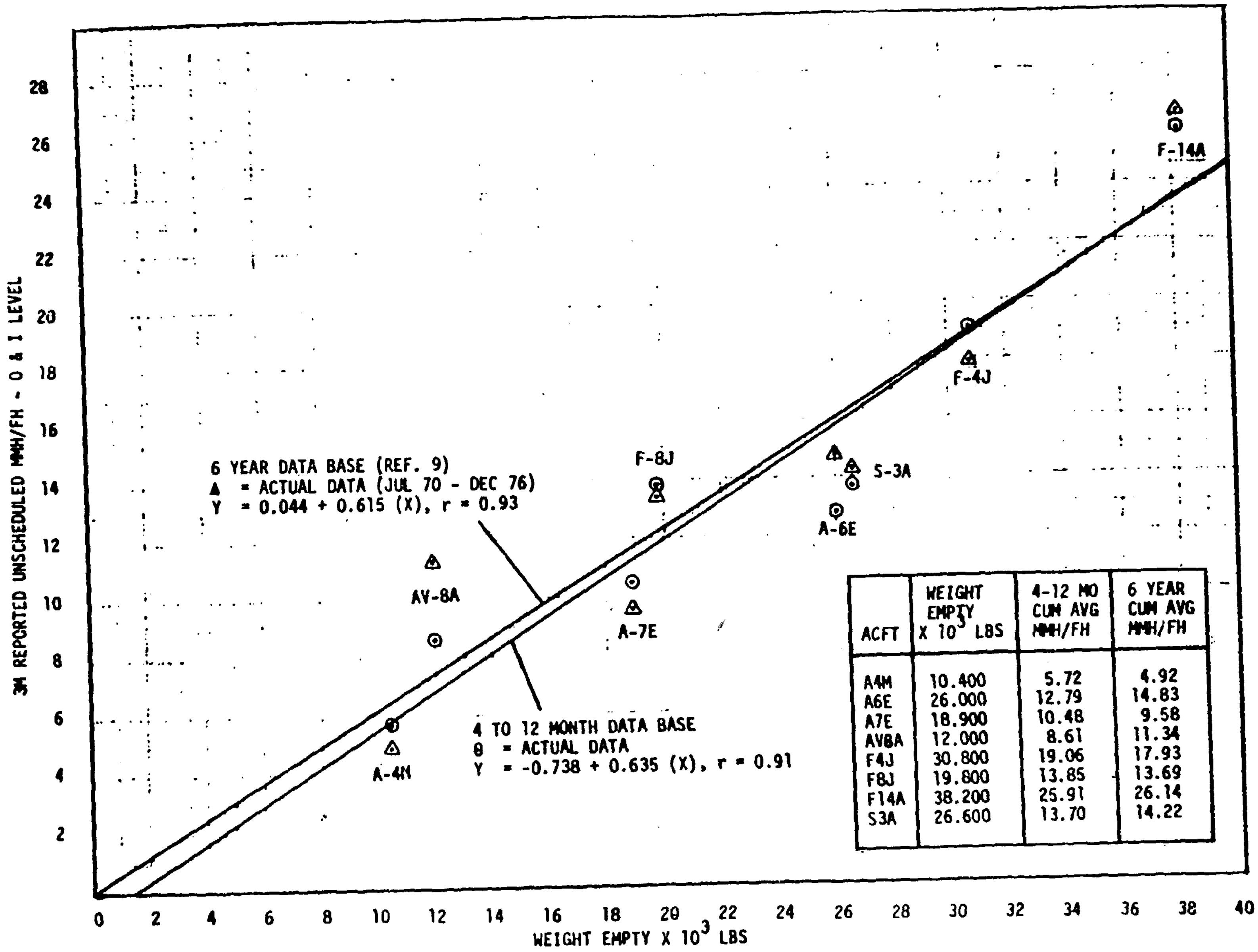
Selection of the two-digit WUC data base differed from the five-digit WUC data base because of data availability. The 4 to 12 month data base was readily available at the start of this Handbook from a previous Vought Research and Development study. Acquisition of a more current and larger data base was originally planned but had to be rejected in order to insure completion of this Handbook in a timely manner.

To verify that the 4 to 12 month data base was representative of mature aircraft in an operational environment, a correlation test was performed which compared sample data with a larger six year data base (Table E-1 of Appendix E). The test was made using total weapon system unscheduled MMH/FH (WUC 11-97) as a function of empty weight, one of the primary aircraft parameters that effects maintenance. Results indicate that the 4 to 12 month data base was representative of a six year data base when taken collectively over the eight aircraft. Figure 3.2 shows the results of this correlation.

A slightly lower degree of confidence existed at the system level where more pronounced variations in system maintenance occur as a function of time. However, the RFP requirements are made at the total weapon system level and not at each two-digit WUC. Accuracy of system level predictions need not be exact as long as the predictions are in the "ballpark" and their summation results in realistic weapon system estimates. The 4 to 12 month FMSO data base used provided this required accuracy.

3.2.3 Standard Work Unit Codes

Individual aircraft WUC's were converted to a Standard WUC format based on guidelines presented in MIL-STD-780 (Reference 14) and NAILSC Equipment Cross-Index Program (ECIP), (Reference 12). This was necessary to insure an adequate two-digit system level comparison among the different aircraft. An example of the variation in aircraft WUC systems is the Fuel Quantity Indicating Subsystem. The A-4M, A-7E, and F-4J list the Fuel Quantity Indicating Subsystem in the Fuel System (WUC 46), while the A-6E, AV-8A, F-14A and S-3A list it under Instruments



ACFT	WEIGHT EMPTY X 10^3 LBS	4-12 MO CUM AVG MMH/FH	6 YEAR CUM AVG MMH/FH
A4M	10.400	5.72	4.92
A6E	26.000	12.79	14.83
A7E	18.900	10.48	9.58
AV8A	12.000	8.61	11.34
F4J	30.800	19.06	17.93
F8J	19.800	13.85	13.69
F14A	38.200	25.91	26.14
S3A	26.600	13.70	14.22

FIGURE 3.2 DATA BASE CORRELATION

(WUC 51). Furthermore, MIL-STD-780 lists fuel quantity under WUC 51 while ECIP lists it under WUC 46. Differences such as these are resolved by using MIL-STD-780 as preferred. Appendix B presents a Standard WUC Matrix developed specifically for this Handbook. Standard WUC's are presented to the third digit for the eight Navy aircraft discussed in the system analysis.

3.3 MAINTENANCE INDEX ESTIMATING RELATIONSHIPS

The MIM uses a set of estimating relationships called Maintenance Index (MI) equations developed through regression analysis techniques. These equations are used to determine system Class 1 Organizational level MMH/FH as a function of applicable aircraft design and performance parameters.

A statistical ranking order was used to identify those aircraft parameters that reflect the highest coefficient of correlation and the lowest Standard Error of Estimate(S) (References 5, 10). Parameters were selected based on several factors: (1) the most statistically valid parameter, (2) the most valid aircraft parameter and (3) the selection of two parameters for multiple regression. This approach resulted in a set of equations which provided good correlation with actual data. An example of the statistical approach for determining MI equations is presented in the following paragraph.

3.3.1 Statistical Airframe/Fuselage Maintenance Manhours per Flight Hour (MMH/FH)

Statistical Airframe/Fuselage (WUC 11, 12) MMH/FH at the Organizational level is estimated by Equation (Eq.) 3.1. Data used in its derivation and equation results are shown in Table 3.3.

$$MI = -0.2180 + 0.5692 \ln(WTMT) + 0.8394 \ln(VMAX) \qquad \text{Eq. 3.1}$$

$r = 0.97$

$S = 0.17$

$2S = \pm 0.34$

TABLE 3.3 AIRFRAME/FUSELAGE ACTUAL AND EQUATION MMH/FH

ACFT	WTMT	VMAX	MMH/FH ACTUAL	MMH/FH EQUATION
A-4M	10.4	0.537	0.400	0.593
A-6E	26.0	0.490	1.011	1.037
A-7E	18.9	0.506	1.071	0.883
AV-8A	12.0	0.525	0.741	0.655
F-4J	30.8	1.230	2.075	1.907
F-8J	19.8	0.989	1.499	1.472
F-14A	38.2	1.314	1.902	2.084
S-3A	26.6	0.410	0.834	0.901

The following definitions are presented to provide additional insight into the nomenclature used:

- <u>Maintenance Index (MI)</u> is defined as the amount of MMH/FH for the given system as measured at the Organizational level.

- o <u>Weight Empty (WTMT)</u> is one of the applicable aircraft parameters for this system as measured in thousands of pounds. Care should be taken when solving the MI equation insuring that the proper decimal point location is observed.

- o <u>Maximum Speed (VMAX)</u> is the second applicable parameter for this system as measured in thousands of knots. Correct decimal point location must be observed when solving the MI equation.

- o <u>Correlation Coefficient (r)</u> is defined as the relative measure of sensitivity between the dependent variable and the independent variable as measured from 0 to 1. The higher the coefficient, the closer "r" approaches 1, the better the data fit. Some systems required numerous regression programs to be run in order to achieve the highest "r" value possible. Values between 0.95 and 0.99 indicate a very high degree of correlation.

- o <u>Standard Error of Estimate (S)</u> measures the average amount of "...dispersion of the Y...[values] away from the line of relationship between the X and Y...[variables]...[1]". The standard error also serves to measure the amount of error in an individual estimate. Assuming that errors conform to a normal distribution, 95% of the errors would fall within ±2 standard errors of the predicted value. Thus a 95% confidence level can be found by using ±2S which for this example is ±0.34 MMH/FH.

Figure 3.3 presents a complete list of the system Maintenance Index equations developed for this Handbook. Aircraft parameter symbols listed are defined in Table 3.5. A graphical presentation of each MI equation is presented in Section 5.0.

STD WUC	SYSTEM	MAINTENANCE INDEX EQUATIONS
11,12	AIRFRAME/FUSELAGE	MI = −0.2180 + 0.5692 LN (WTMT) + 0.8394 LN (VMAX)
13	LANDING GEAR	MI = 0.1738 + 0.0241 (WTLAND)
14	FLIGHT CONTROLS	MI = −0.3963 + 0.0274 (WTMT) + 0.8036 (VMAX) + 0.569 (KWING)
23	ENGINE	MI = −0.3960 + 0.0467 (THRUST) + 0.3414 (ENGQTY)
24	AUXILIARY POWER PLANT	MI = 0.192 (KAPU)
29	POWER PLANT INSTL	MI = −0.0943 + 0.0059 (THRUST) + 0.1174 (ENGQTY)
41	AIR CONDITIONING	MI = −0.0717 + 0.0103 (WTMT) + 0.0364 (WTAVIN) + 0.166 (KBLC)
42	ELECTRICAL	MI = −0.1419 + 0.0259 (WTMT) −0.0485 (GENKVA)
44	LIGHTING	MI = −0.2305 + 0.1652 (WAREA) +0.6472 (FUSLEN)
45	HYDRAULICS	MI = −0.1260 + 0.0066 (WTMT) + 0.3671 (VMAX)
46	FUEL	MI = −0.2947 + 0.1148 (FUEL) + 0.6060 (VMAX)
47	OXYGEN	MI = 0.034
49	MISC. UTILITIES	MI = −0.0275 + 0.0028 (WTMT)
51	INSTRUMENTS	MI = 0.0465 + 0.2906 (WTAVUN)
56	FLIGHT REFERENCE	MI = −0.0890 + 0.2182 (WTAVIN)
57	INTEG GUID/FLT CONT	MI = −0.3225 + 0.1783 LN (WTMT)
60	COMMUNICATIONS	MI = 0.0428 + 0.0104 (WTMT) + 0.0460 (WTAVIN)
71, 72, 73, 74	NAV/WEAPONS CONTROL	MI = 1.3541 + 0.8715 LN (WTAVUN)
75	WEAPON DELIVERY	MI = 0.1563 + 0.0040 (WTMT) + 0.0367 (PYLQTY) + 0.82 (KGUN)
76	ECM	MI = −0.0645 + 0.0104 (WTMT)
90	MISC EQUIPMENTS	MI = 0.0272 −0.0012 (WTMXTO) + 0.0491 (CREW) + 0.014 (KCHUTE)

Figure 3.3 Baseline O – Level MMH/FH Estimating Relationships

1. H. L. Balsley, <u>Statistical Method</u>, Littlefield, Adams and Co., p. 179.

The predicted value calculated by each MI equation is a "baseline" estimate based on the maintainability characteristics of existing inventory aircraft. For a new weapon system, a "predicted" estimate made by the contractor should be less than the "baseline" estimate depending on the additional maintainability features implemented in the design. The measurement of the delta improvement is discussed in paragraph 3.5.3.

3.4 FREQUENCY INDEX ESTIMATING RELATIONSHIPS

In addition to the MI equations previously discussed, the MIM uses a second set of estimating relationships called Frequency Index (FI) equations. These equations are used to determine system Class 1 MA/FH at the Organizational level as a function of applicable aircraft design and performance parameters. The same regression techniques used to develop MI equations were used to develop FI equations. An example of the statistical approach for determining a system Frequency Index follows.

3.4.1 Statistical Airframe/Fuselage Maintenance Actions per Flight Hour (MA/FH)

Statistical Airframe/Fuselage MA/FH at the Organizational level is estimated by Equation 3.2. Data used in its derivation and equation results are shown in Table 3.4.

$$FI = -0.2931 + 0.1800 \ln (WTMT) + 0.0525 \ln (VMAX) \qquad \text{Eq. 3.2}$$

$$r = 0.971$$
$$S = 0.028$$
$$2S = \pm 0.036$$

TABLE 3.4 AIRFRAME/FUSELAGE ACTUAL AND EQUATION MA/FH

ACFT	WTMT	VMAX	MA/FH ACTUAL	MA/FH EQUATION
A-4M	10.4	0.537	0.081	0.095
A-6E	26.0	0.490	0.233	0.200
A-7E	18.9	0.506	0.283	0.256
AV-8A	12.0	0.525	0.125	0.120
F-4J	30.8	1.230	0.341	0.335
F-8J	19.8	0.989	0.233	0.243
F-14A	38.2	1.314	0.371	0.377
S-3A	26.6	0.410	0.210	0.250

Figure 3.4 presents a complete list of the system Frequency Index equations. A graphical presentation of each FI equation is presented in Section 5.0. As with the Maintenance Index, the predicted value calculated by each FI equation is a "baseline" estimate.

STD WUC	SYSTEM	FREQUENCY INDEX EQUATIONS
11,12	AIRFRAME/FUSELAGE	FI = −0.2931 + 0.1800 LN (WTMT) + 0.0525 LN (VMAX)
13	LANDING GEAR	FI = 0.1019 + 0.1850 (KE)
14	FLIGHT CONTROLS	FI = 0.0112 + 0.1183 (VMAX) + 0.022 (KWING)
23	ENGINES	FI = −0.0194 + 0.0023 (THRUST) + 0.0340 (ENGQTY)
24	AUXILIARY POWER PLANT	FI = 0.037 (KAPU)
29	POWER PLANT INSTL	FI = −0.0069 + 0.0023 (THRUST) + 0.0028 (ENGQTY)
41	AIR CONDITIONING	FI = 0.0019 + 0.0013 (WTMT) + 0.0072(WTAVIN) + 0.016 (KBLC)
42	ELECTRICAL	FI = −0.0100 + 0.0027 (WTMT) + 0.0092 (GENKVA)
44	LIGHTING	FI = −0.1458 −0.0333 (WAREA) + 0.4444 (FUSLEN)
45	HYDRAULICS	FI = 0.0191 + 0.0361 (VMAX)
46	FUEL	FI = 0.0056 + 0.0465 (VMAX)
47	OXYGEN	FI = 0.019
49	MISC UTILITIES	FI = −0.0036 + 0.0004 (WTMT)
51	INSTRUMENTS	FI = 0.0360 + 0.0467 (WTAVUN)
56	FLIGHT REFERENCE	FI = −0.0106 + 0.0483 (WTAVIN)
57	INTEG GUID/FLT CONT	FI = 0.0376 + 0.0201 LN (WTAVUN)
60	COMMUNICATIONS	FI = 0.0194 + 0.0037 (WTMT) + 0.0190 (WTAVIN)
71, 72 73,74	NAV/WEAPONS CONTROL	FI 0.3616 + 0.2379 LN (WTAVUN)
75	WEAPON DELIVERY	FI = −0.0087 + 0.0006 (WTMT) + 0.0034 (PYLQTY) + 0.017 (KGUN)
76	ECM	FI = −0.0049 + 0.0016 (WTMT)
90	MSC EQUIPMENTS	FI = −0.0057 −0.0003 (WTMXTO) + 0.0267 (CREW) + 0.007 (KCHUTE)

Figure 3.4 Baseline O – Level MA/FH Estimating Relationships

3.5 MODEL OPERATION

The Maintainability Index Model (MIM) is a mathematical tool for estimating maintenance requirements for a new weapon system. Execution of the MIM is accomplished by solving a set of index equations and general mathematical relationships. Inputs include applicable aircraft design characteristics, system constants and contractor predictions. Outputs include MMH/FH, MA/FH, MMH/MA, EMT/MA at O and I levels for a 3-M (Class 1) and FSE (Class 3) environment. A logic flow diagram depicting the operation of the MIM is shown in Figure 3.1. A discussion on model operation follows.

3.5.1 Aircraft Design and Performance Parameters

As the physical size, performance and capability of a weapon system varies, so does its maintenance requirements. The MIM is built around a set of 21 aircraft parameters that were determined to be the primary design characteristics that effect aircraft maintenance. In addition, values for these parameters are readily available during conceptual and development design phases. Table 3.5 presents a list of those parameters along with F-18A predicted values used as an example.

TABLE 3.5 AIRCRAFT PARAMETERS

SYMBOL	AIRCRAFT PARAMETERS	F-18A EXAMPLE
WAREA	Area, Wing -10^3 feet^2	.390
KAPU	Auxiliary Power Unit Factor*	1
KBLC	Boundary Layer Control Factor*	0
CREW	Crew Size	1
KCHUTE	Drag Chute Factor*	0
FUEL	Fual Capacity, Internal - 10^3 gals	1.615
GENKVA	Generator Electrical Power -10^2 KVA	.80
KGUN	Gun Factor*	1.0
KE	Kinetic Energy (WTLAND X VMIN^2) -10^9 lbs-knots^2	.348
FUSLEN	Length, Fuselage -10^2 feet	.56
ENGQTY	Number of Engines	2
PYLQTY	Number of Pylons	9
VMAX	Speed, Maximum at Altitude -10^3 knots	1.085
VMIN	Speed, Minimum Carrier Approach -10^3 knots	.130
THRUST	Thrust per Engine Uninstalled -10^3 lbs	16.000
WTAVIN	Weight, Avionics Installed -10^3 lbs	1.293
WTAVUN	Weight, Avionics Uninstalled -10^3 lbs	1.060
WTMT	Weight, Empty -10^3 lbs	20.583
WTLAND	Weight, Landing Clean -10^3 lbs	23.083
WTMXTO	Weight, Maximum Take-Off -10^3 lbs	50.064
KWING	Wing Sweep Factor*	0

* 1 IF APPLICABLE, 0 IF NOT

The first step in analyzing the maintenance requirements of a weapon system is to complete a worksheet for the weapon system under consideration, similar to Table 3.5, using the aircraft parameters cited therein. After that, maintenance estimates (baseline and predicted) for each system can be determined using techniques presented in Section 5.0.

3.5.2 System Constants

Class 1 O-level MMH/FH and MA/FH are the two maintainability parameters determined through regression analysis techniques. The remaining parameters are calculated using general mathematical relationships and system constants where regression analysis techniques were considered but rejected because of invalid correlation results and to minimize handbook complexity.

System constants are averages based on historical maintenance data concerning past performance. "...The assumption is made that the elemental activities for a new system will closely resemble the systems for which data was collected"[2]. That is, if a given system averages 1.5 Men per Maintenance Action, then the same number of men will be required for the new system. Exceptions require maintainability documentation. Definitions of system constants plus sample calculations follow.

2. D. D. Gregor, Donna F. Harmon, Patricia A. Pate, "Maintainability Estimating Relationships", p.20.

Manning Ratio (MR) is defined as the average number of men required per unscheduled maintenance action. For each system, a Class 1 MR is determined by averaging individual aircraft Class 1 MEN per Equation 3.3.

$$MR = \frac{\sum_{i=1}^{n} MEN_i}{n} \qquad \text{Eq. 3.3}$$

where,

MR = Average number of men per maintenance action per given system
MEN = Average number of men per maintenance action per aircraft
n = Number of aircraft used in the regression analysis
i = 1, 2, 3.....n

Class 1 MR is used in the MIM to determine EMT/MA for a new aircraft as shown by Equation 3.4

$$EMT/MA = MMH/MA \div MR \qquad \text{Eq. 3.4}$$

Maintenance Index I-Level Ratio (MIIR) is defined as the ratio of I-level MMH/FH to O-level MMH/FH. Individual aircraft MIIR's are summed and averaged as shown in Equation 3.5.

$$MIIR = \frac{\sum_{i=1}^{n} \left(\frac{MMH/FH_I}{MMH/FH_O}\right)_i}{n} \qquad \text{Eq. 3.5}$$

where,

MMH/FH_O = MMH/FH at O level
MMH/FH_I = MMH/FH at I level

Using the Airframe/Fuselage System (Table 3.6) as an example, Class 1 MIIR was calculated as follows:

$$MIIR_{11,12} = \frac{\left(\frac{MMH/FH_I}{MMH/FH_O}\right)_{A-4M} + \left(\frac{MMH/FH_I}{MMH/FH_O}\right)_{A-6E} + \left(\frac{MMH/FH_I}{MMH/FH_O}\right)_{A-7E} + \ldots + \left(\frac{MMH/FH_I}{MMH/FH_O}\right)_{S-3A}}{n}$$

$$= \frac{\frac{0.022}{0.400} + \frac{0.043}{1.011} + \frac{0.151}{1.071} + \ldots + \frac{0.050}{0.834}}{8}$$

$$= \frac{0.055 + 0.042 + 0.141 + \ldots + 0.060}{8} = 0.04$$

TABLE 3.6 TWO-DIGIT WUC MAINTENANCE DATA SUMMARY

WUC: 11, 12 SYSTEM: Airframe and Fuselage

ACFT	CLASS 1 MAINTENANCE - 3M										
	O LEVEL					I LEVEL					TOTAL
	MMH/FH	MA/FH	MMH/MA	EMT/MA	MEN	MMH/FH	MA/FH	MMH/MA	EMT/MA	MEN	MMH/FH
A4M	.400	.081	4.94	2.73	1.8	.022	.005	4.40	3.43	1.3	.422
A6E	1.011	.283	3.56	1.93	1.8	.043	.006	7.13	4.78	1.5	1.054
A-7E	1.071	.233	4.60	2.36	2.0	.151	.007	21.57	13.02	1.7	1.222
AV8A	.741	.125	5.93	3.53	1.7	.005	.003	1.68	0.98	1.7	.746
F4J	2.075	.341	6.09	3.43	1.8	.044	.006	7.33	4.12	1.8	2.119
F8J	1.499	.233	6.43	3.04	2.1	.086	.015	5.73	5.35	1.1	1.585
F14A	1.902	.371	5.13	2.48	2.1	.221	.014	15.79	9.86	1.6	2.123
S3A	.834	.210	3.97	2.14	1.8	.050	.011	4.55	3.13	1.5	.884
	CLASS 3 MAINTENANCE - DESIGN EQUIVALENT										
A4M	.203	.054	3.76	1.90	2.0	.015	.005	3.13	2.48	1.3	.219
A6E	.554	.226	2.45	1.29	1.9	.028	.006	4.63	3.37	1.4	.581
A7E	.625	.200	3.13	1.49	2.1	.092	.006	15.32	9.88	1.6	.718
AV8A	.424	.100	4.24	2.33	1.8	.004	.003	1.35	0.80	1.7	.428
F4J	1.161	.284	4.09	2.15	1.9	.028	.006	4.76	2.35	2.0	1.190
F8J	.871	.204	4.27	1.88	2.3	.055	.014	3.94	3.08	1.3	.926
F14A	.951	.273	3.48	1.10	2.2	.120	.013	9.23	6.35	1.5	1.071
S3A	.424	.165	2.55	1.35	1.9	.034	.011	3.06	2.21	1.4	.457

Class 1 MIIR is used in the MIM to determine I-level MMH/FH for a new system design as shown by Equation 3.6.

$$MMH/FH_I = MMH/FH_O \times MIIR \qquad \text{Eq. 3.6}$$

Frequency Index I-Level Ratio (FIIR) is defined as the ratio of I-level MA/FH to O-level MA/FH. Individual FIIR's for each aircraft are summed and averaged per Equation 3.7.

$$FIIR = \frac{\sum_{i=1}^{n} \left(\frac{MA/FH_I}{MA/FH_O}\right)_i}{n} \qquad \text{Eq. 3.7}$$

Using the Airframe/Fuselage System as an example, Class 1 FIIR was calculated to be 0.07.

Class 1 FIIR is used in the MIM to determine I-level MA/FH for a new system using Equation 3.8.

$$MA/FH_I = MA/FH_O \times FIIR \qquad \text{Eq. 3.8}$$

Maintenance Index Defect Ratio (MIDR) is defined as the ratio of Class 3 O-level MMH/FH to Class 1 O-level MMH/FH. It identifies that portion of Class 1 maintenance considered contractor controllable through design. A MIDR is determined for each system by summing and averaging the individual aircraft MIDR's per Equation 3.9.

$$MIDR = \frac{\sum_{i=1}^{n} \left(\frac{\text{Class 3 O-Level MMH/FH}}{\text{Class 1 O-Level MMH/FH}}\right)_i}{n} \qquad \text{Eq. 3.9}$$

Using the Airframe/Fuselage System (Table 3.6) as an example, MIDR was calculated as follows:

$$MIDR_{11,12} = \frac{\left(\frac{MMH/FH_{3,O}}{MMH/FH_{1,O}}\right)_{A-4M} + \left(\frac{MMH/FH_{3,O}}{MMH/FH_{1,O}}\right)_{A-6E} + \ldots + \left(\frac{MMH/FH_{3,O}}{MMH/FH_{3,O}}\right)_{S-3A}}{n}$$

$$= \frac{\frac{0.200}{0.400} + \frac{0.524}{1.011} + \ldots + \frac{0.374}{0.834}}{8}$$

$$= \frac{0.50 + 0.52 + \ldots + 0.45}{8}$$

$$= 0.54$$

The MIDR is used to determine the Design Maintenance Index scale for the MI graphs of Section 5.0.

Frequency Index Defect Ratio (FIDR) is defined as the ratio of Class 3 O-level MA/FH to Class 1 O-level MA/FH. It identifies that portion of Class 1 maintenance actions classified as Design Induced Malfunctions. A FIDR is determined for each system by summing and averaging individual aircraft FIDR's per Equation 3.10.

$$FIDR = \frac{\sum_{i=1}^{n} \frac{\text{Class 3 O-Level MA/FH}}{\text{Class 1 O-Level MA/FH}}}{n} \qquad \text{Eq. 3.10}$$

Using the Airframe/Fuselage System as an example, FIDR was calculated to be 0.79. This means that 79% of the reported 3-M data is considered contractor controllable through design. The remaining 21% is primarily attributed to no defect, cannibalization and missing fastener maintenance actions and is considered Navy controllable. The FIDR is used to determine the design Frequency Index scale for the FI graphs of Section 5.0.

3.5.3 Technology Improvement Index

"Maintainability estimating techniques must be responsive to design technology advancements as well as design parameters and historical maintenance data"[3]. The MIM calculates baseline maintenance requirements reflecting state-of-the-art technology and its corresponding R&M effort. The model is also receptive to advances in design technology. Inherently, an increase in aircraft performance results in an increase in maintenance requirements. To minimize or reverse this trend, greater emphasis must be placed on R&M through technology improvements. This relationship is shown in Figure 3.5.

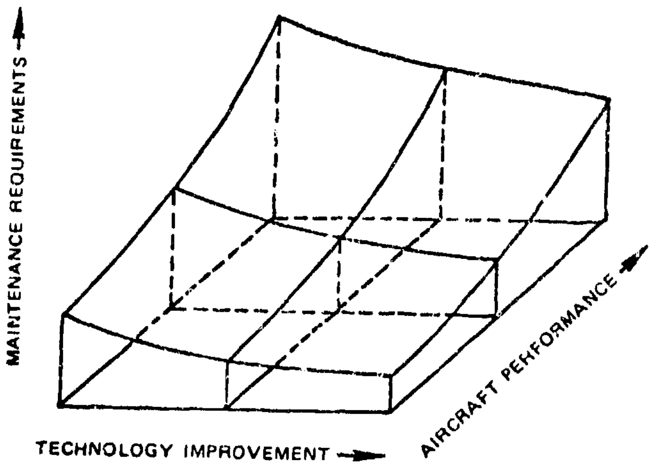


Figure 3.5 Maintenance Requirements (Ref. 10)

3. Idem., p.23.

Engineering improvements which reduce maintenance resources and frequency of maintenance in a new design are measured by the Technology Index (TI). Using data from the MIM and predictions made by the contractor, a Technology Index can be calculated for each system per Equation 3.11.

$$TI = \left| \frac{BMMH/FH - PMMH/FH}{BMMH/FH} \right| \times 100\% \qquad \text{Eq. 3.11}$$

where,

TI = Technology Improvement Index
PMMH/FH = Predicted MMH/FH
BMMH/FH = Baseline MMH/FH

Using the Airframe/Fuselage System as an example, Class 1 O-level MMH/FH Technology Index for the F-18A was found to be 53%.

$$TI = \left| \frac{1.572 - 0.746}{1.572} \right| \times 100\% = 53\%$$

where 0.746 is the 3-M equivalent MMH/FH of the contractor's predicted 0.403 value. (Refer to Section 5.0, paragraph 5.1.3 for additional information.) This indicates that the contractor predicts the F-18A Airframe/Fuselage System to be 53% better than a comparable state-of-the-art design. Substantiating documentation for achieving this prediction should be presented through qualitative maintainability features in the contractor's proposal.

Technology Indexes for MA/FH, EMT/MA and MMH/MA are determined in similar fashion and are discussed in Section 5.0, paragraph 5.1.3.

3.6 MODEL VALIDATION

Validation of the MIM is achieved by comparing actual data with calculated values. The primary outputs of the model are maintenance estimates measured in Class 1 O-level MMH/FH and MA/FH by two-digit WUC.

System validation is presented in Section 5.0 by two-digit WUC. Most all systems show Correlation Coefficients in the high 90's indicating excellent data correlation. Validation at the weapon system level is achieved by summing actual and calculated system values (WUC's 11-90) and comparing results. Figure 3.6 shows model validation for MMH/FH using only those aircraft used in each system equation. A similar validation was done for MA/FH with excellent correlation results ($r = 0.99$).

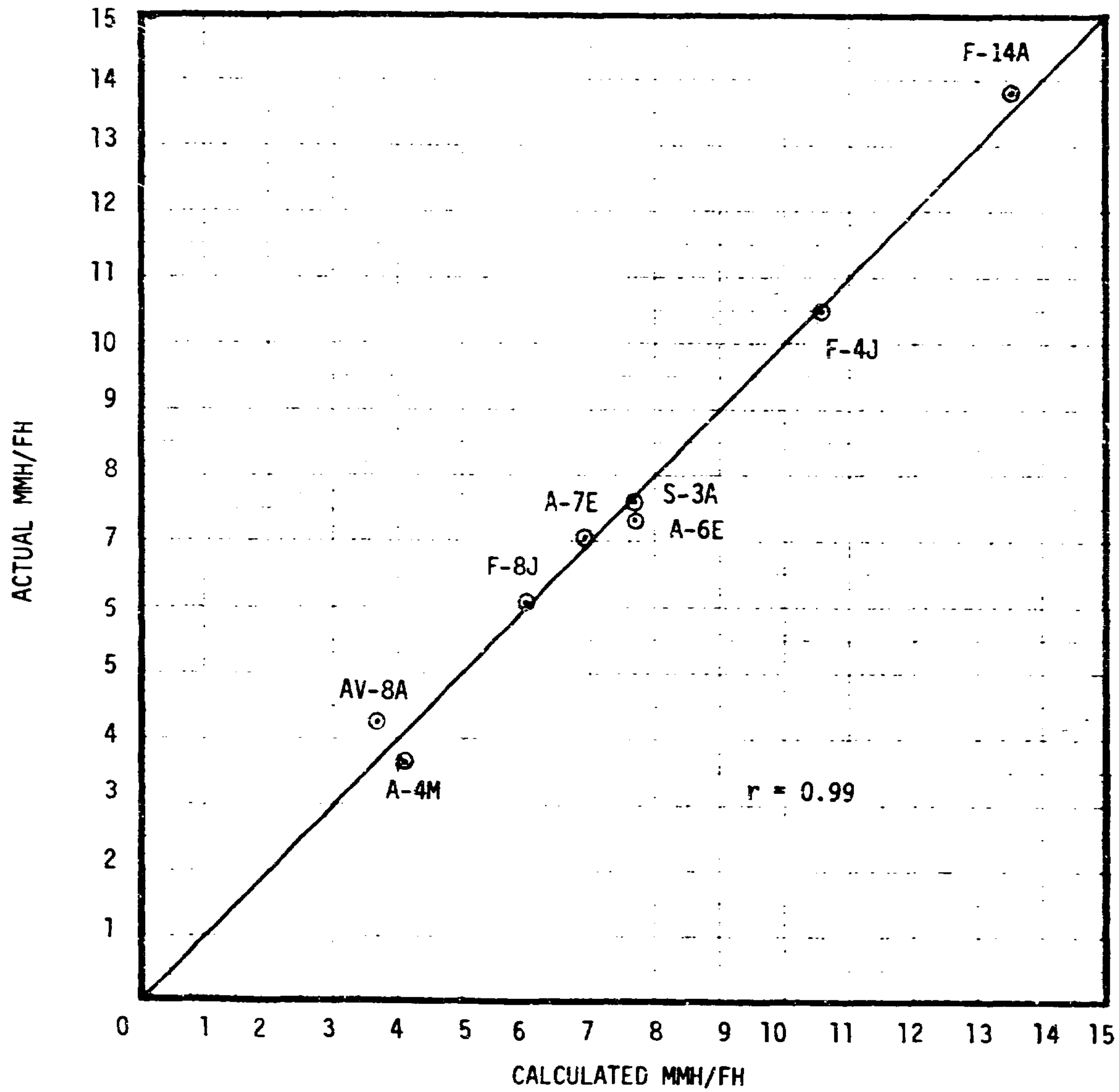


FIGURE 3.6 MODEL VALIDATION

PART II

MAINTAINABILITY INDEX MODEL APPLICATION INSTRUCTIONS

4.0 WEAPON SYSTEM ANALYSIS

Part II provides the instructions for the application of the Maintainability Index Model (MIM) in establishing maintainability requirements and evaluating contractor predictions. Aircraft maintenance is addressed at the weapon system level (Section 4.0) and at the system level (Section 5.0).

This section addresses maintenance expenditures at the weapon system level for selected Navy Fighter, Attack and ASW aircraft. The parameter most often used to measure maintenance at this level is MMH/FH because it takes into consideration frequency of maintenance, repair time and manning requirements. Historical data will be analyzed and the results will be used to derive a set of MMH/FH conversion charts. These charts have two applications: (1) to convert Class 1 Gross Maintenance to Class 3 Design Maintenance and vice-versa and (2) to aid the user in establishing MMH/FH requirements for a specified design Technology Improvement factor.

Since contractual requirements on new aircraft are normally made at the weapon system level, it is imperative that the characteristics of MMH/FH be investigated and the findings made known. Appendix E presents a study on some of the factors that effect MMH/FH during the life cycle of an aircraft. Such variables as failure rate, aircraft utilization rate and weapon system age are investigated and their impact on MMH/FH should be considered when establishing program requirements.

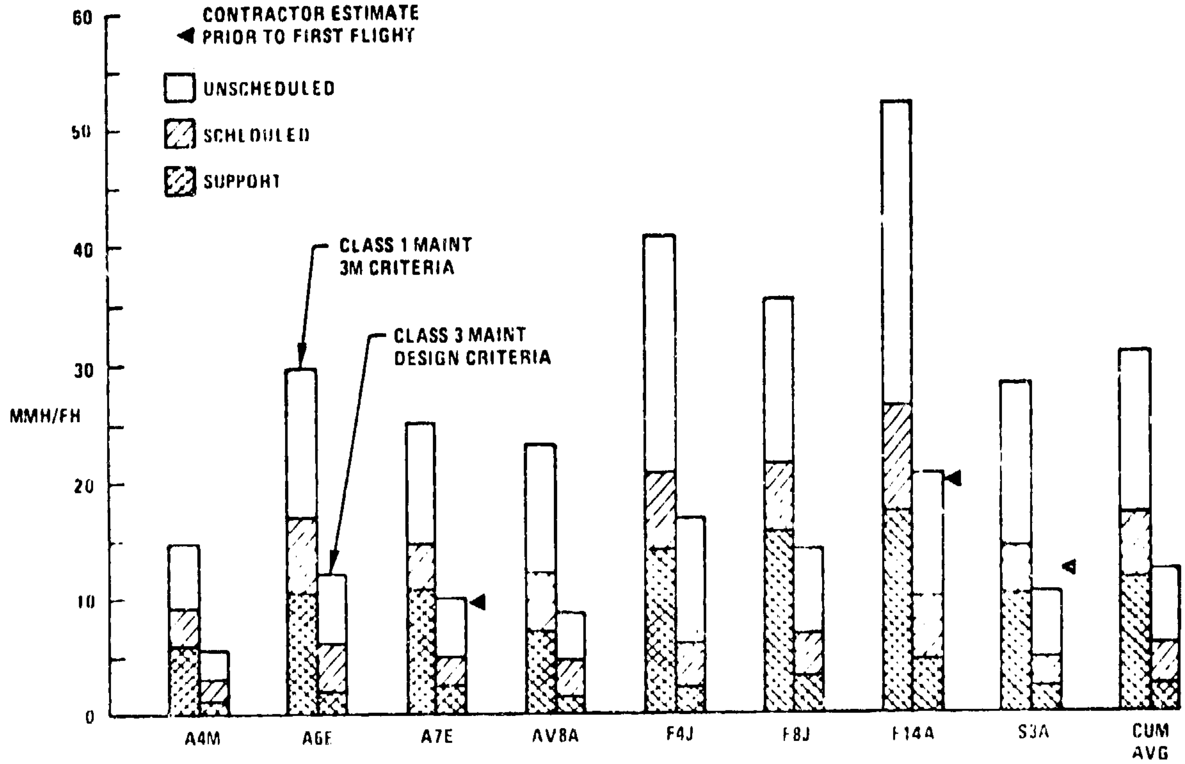


Figure 4.1 Aircraft MMH/FH Classification

4.1 ANALYSIS OF WEAPON SYSTEM MAINTENANCE

Figure 4.1 shows a graphical presentation of historical MMH/FH data from the MIM historical data base (Appendix A). For each aircraft, two classes of maintenance and three types of maintenance are shown. Analysis indicates all aircraft tend to exhibit similar distributions between type maintenance categories and between both classes of maintenance. This is not surprising since only the MMH/FH values vary while the ratios remain approximately the same. A proportional amount of Navy controllable maintenance actions and time are deleted from each aircraft by converting from one class of maintenance to another. The cumulative average MMH/FH for all aircraft shows that the ratio of Class 1 to Class 3 maintenance is approximately 2.5 to 1. Applying this ratio to a new design, an increase in "design-to" maintenance is magnified by a factor of 2.5 in the operational environment. Also shown in Figure 4.1 are the contractor estimates prior to first flight. It is interesting to note that although these estimates were based on different ground rules, each tracks fairly close with Class 3 historical data. In summary, the technique used to convert Class 1 to Class 3 maintenance criteria appears valid.

The cumulative average results of Figure 4.1 can also be displayed in pie-chart form as shown below (Figure 4.2).

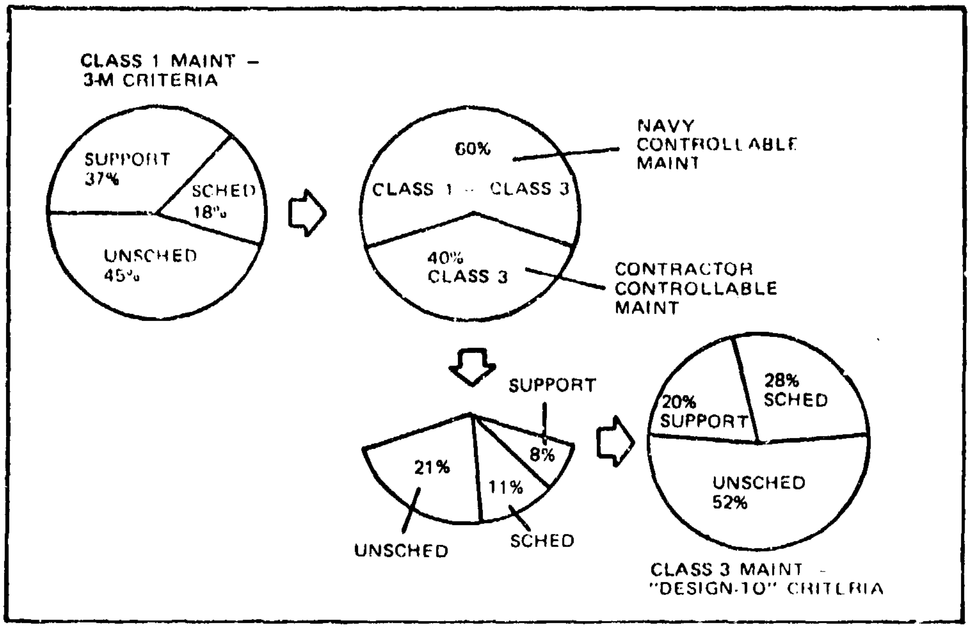


Figure 4.2 Class 1 – Versus – Class 3 Maintenance

The breakdown of Class 1 maintenance indicates that unscheduled MMH/FH accounts for less than half the total maintenance expenditure. Support actions are another high contributor to total maintenance since they are a function of unscheduled maintenance. For every one unscheduled MMH/FH reported, approximately 0.8 support MMH/FH are required. Classifying total maintenance another way, 40% is contractor controllable while the remaining 60% is Navy controllable maintenance. What this means is that: (1) only 21% of the reported unscheduled maintenance (45%) is considered Class 3 Contractor Controllable Design

Maintenance, (2) only 11% of the reported scheduled maintenance (18%) is contractor controllable and (3) only 8% of the reported support actions (37%) is contractor controllable. These numbers are cumulative averages of the eight aircraft and may vary somewhat between aircraft. For more exact values, MMH/FH conversion charts need to be developed.

4.2 MAINTENANCE MANHOURS PER FLIGHT HOUR CONVERSION CHARTS

The relationship between Class 1 MMH/FH and Class 3 MMH/FH at the weapon system level can be expressed through a set of four conversion charts. These charts will enable the user to rapidly convert Fleet reported data to a design equivalent and vice versa. In addition, these charts can be used to establish requirements for RFP's.

Figure 4.3 depicts a conversion chart for unscheduled O and I MMH/FH. Regression analysis techniques were applied to the MIM data base (Appendix A) to determine the slope of the lines for Class 2 and Class 3 MMH/FH. The difference between the lines defines the type of 3-M data excluded in converting from one class of maintenance to another. Similar charts for scheduled maintenance and support are shown in Figure 4.4 and 4.5, respectively. The combined results of these three charts are depicted in Figure 4.6.

Typical use of these charts as an evaluation tool follows. If a contractor predicts his aircraft is "designed to" 7.5 total MMH/FH (Class 3), then using Figure 4.6 this value would equate to 20 MMH/FH (Class 1) in an operational environment. Or, if an aircraft is experiencing 28 MMH/FH in the Fleet, its design equivalent would be 11 MMH/FH. Similarly using Figure 4.3, a Class 1 unscheduled MMH/FH of 8.0 would equate to 3.6 Class 3 unscheduled MMH/FH.

Typical use of these charts for establishing requirements is as follows. Preliminary operational/mission data input to the model indicates a certain type aircraft will exhibit 15.0 Class 1 unscheduled MMH/FH in an operational environment using state-of-the-art technology. The Navy specifies that a design technology improvement of 40% is required in the next generation of aircraft. This adjusts the baseline value to 9.0 Class 1 unscheduled MMH/FH. Using Figure 4.3, this equates to 4.2 Class 3 unscheduled MMH/FH as a "design-to" requirement.

A few points on the use of these conversion charts are in order. First, it is not the intent of this Handbook to have a series of charts used to evaluate weapon system maintainability in lieu of a maintainability demonstration. Each weapon system is unique and a formal demonstration/FSE is still required to determine an aircraft's inherent maintainability or Class 3 MMH/FH. Second, conversion charts cannot establish design technology improvements for a new weapon system. Realistic and achievable MMH/FH requirements need to be established.

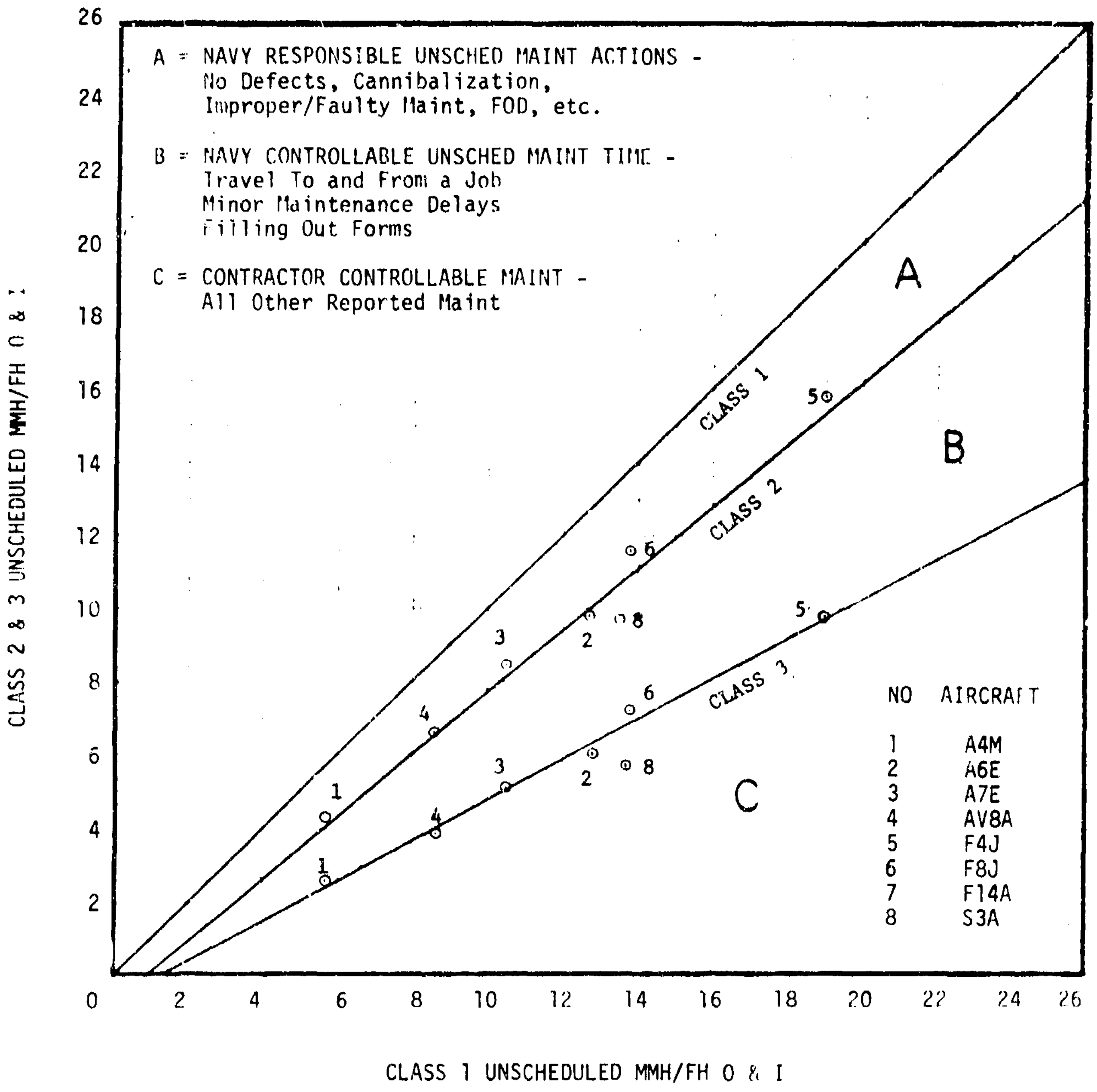


FIGURE 4.3 UNSCHEDULED MMH/FH CONVERSION CHART

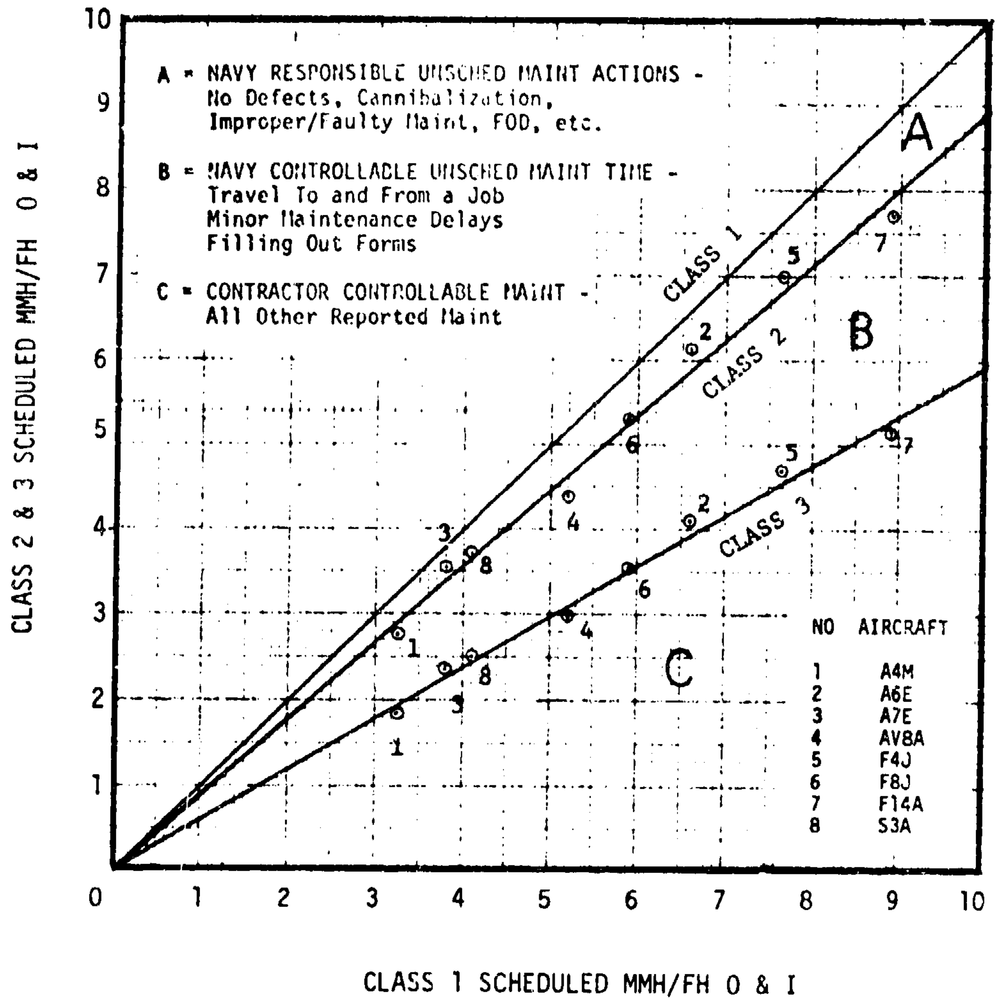


FIGURE 4.4 SCHEDULED MMH/FH CONVERSION CHART

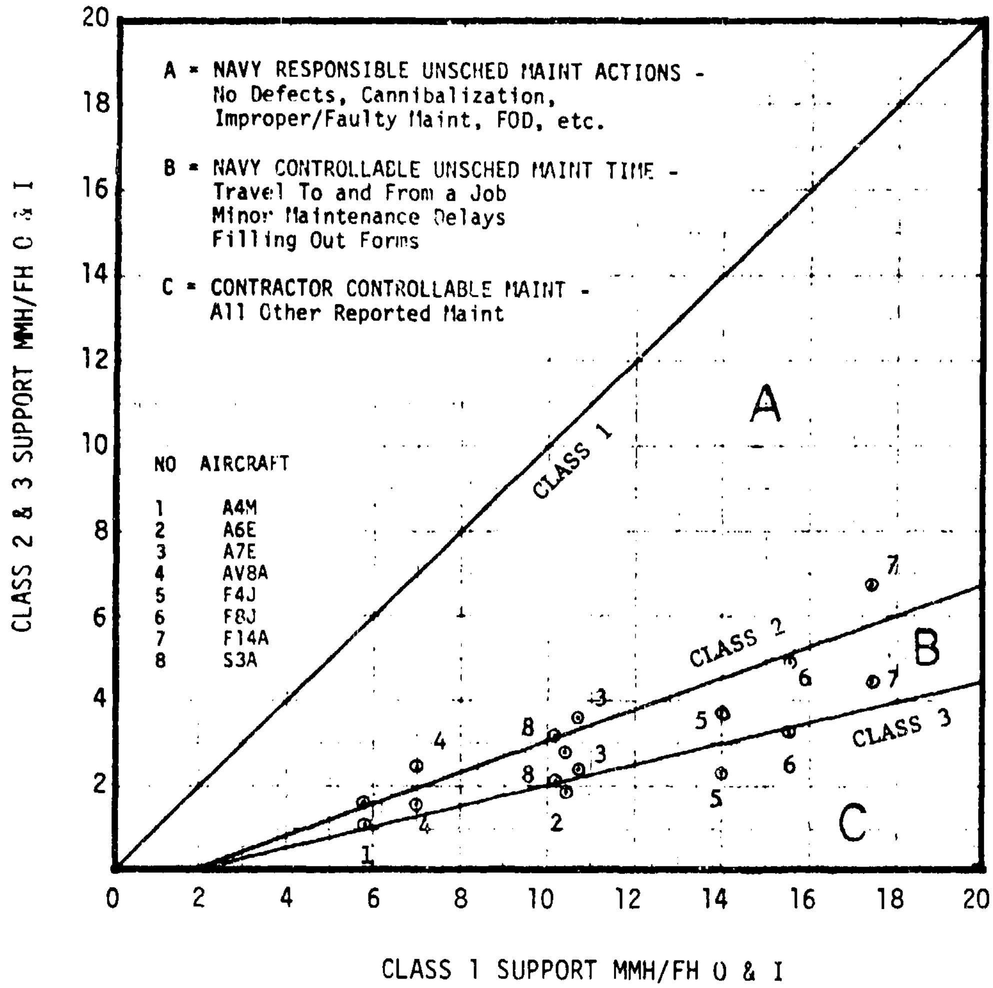


FIGURE 4.5 SUPPORT MMH/FH CONVERSION CHART

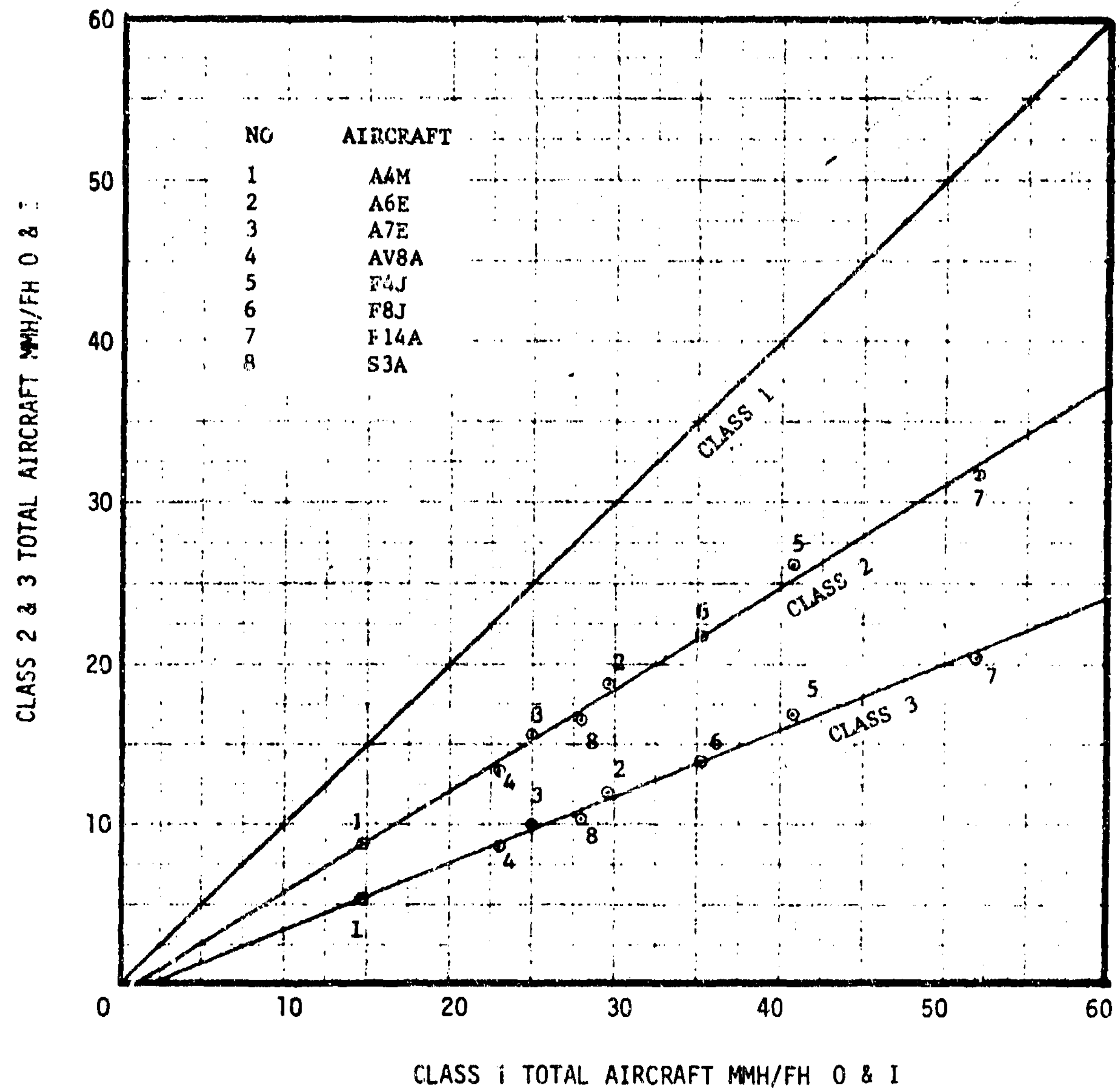


FIGURE 4.6 TOTAL AIRCRAFT MMH/FH CONVERSION CHART

5.0 SYSTEM ANALYSIS

This section of the Handbook presents the methodology and techniques used to evaluate a contractor's quantitative maintainability predictions at the two-digit WUC level. In addition, the user can apply these techniques to establish system goals and total weapon system requirements by specifying desired design technology improvements.

The Handbook is arranged numerically by WUC starting with the Airframe System (WUC 11) and ending with Miscellaneous Systems/Equipment (WUC 90).

Two-digit WUC evaluation is accomplished using techniques previously described, predictions submitted by the contractor and methodology presented in this section. Thirty-five systems are classified into a Standard WUC (Appendix B) and condensed into twenty-one system groups. Condensed groupings are necessary to permit a valid statistical analysis of the data.

The methodology used to evaluate the maintenance requirements of a new weapon system encompasses using historical data, regression analysis techniques, graphical techniques, contractor predictions and an evaluation worksheet. For each system group, a series of tables and figures consistent in title and numbering are presented. To aid in understanding the methodology presented, the F-18A contractor predictions (Reference 8) are included as an example. A brief discussion on the content of the tables, graphs and worksheet follows. Refer to the Airframe/Fuselage System, paragraph 5.1, for sample formats and a more detailed explanation.

o TWO-DIGIT WUC MAINTENANCE DATA SUMMARY (TABLE 5.1-1)

This table contains historical maintenance data extracted from Appendix A and used in the system analysis. Data is broken down into two classes of maintenance and two levels of maintenance for five parameters. All total, 22 quantitative values are shown which describe the basic maintenance requirements of these aircraft. When the two-digit evaluation for a new system is completed, the information provided in this section will enable its user to generate a similar set of values.

o REGRESSION ANALYSIS SUMMARY (TABLE 5.1-2)

This table summarizes the results of a regression analysis program used to correlate aircraft design and performance characteristics with historical maintenance data. For each system, or group of systems, one or two applicable design/performance parameters were correlated with Class 1 O-level MMH/FH (Maintenance Index). A similar treatment was performed for Class 1 O-level MA/FH (Frequency Index). Statistical parameter results are included for each index equation.

o SYSTEM MAINTENANCE INDEX GRAPH (FIGURE 5.1-1)

The Maintenance Index (MI) graph shows the relationship between baseline and predicted O-level MMH/FH requirements for a given design. The baseline curve was developed from the regression equation presented in Table 5.1-2 using

graphical techniques. The advantage of the graph is that it converts an abstract equation into an easy to understand visual picture. The sensitivity of system maintenance is shown as a function of aircraft speed, weight, thrust, etc. Each graph has two MMH/FH scales. The upper scale called Design MI identifies Class 3 maintenance. The lower scale called 3-M MI identifies Class 1 maintenance. Conversion between the two scales is determined through the Maintenance Index Defect Ratio which is unique for each system. Solution of the graph enables the user to (1) identify the minimum acceptable maintenance expenditure for the given design as measured in an operational environment, (2) convert contractor predicted MMH/FH to a 3-M equivalent and (3) identify the predicted improvement or degradation over a baseline design. See paragraph 5.1.1 for a more detailed explanation on the procedure for evaluating a system Maintenance Index.

o SYSTEM FREQUENCY INDEX GRAPH (FIGURE 5.1-2)

This illustration is similar to the Maintenance Index graph except MA/FH is plotted instead of MMH/FH. See paragraph 5.1.2 for details.

o WORKSHEET FOR EVALUATING SYSTEM MAINTENANCE REQUIREMENTS (FIGURE 5.1-3)

This worksheet is used in evaluating system quantitative maintenance estimates for a new design. To simplify use of the worksheet, it is divided into three parts. Part I calls for RFP response data. From the contractor's maintainability proposal, the user must extract predicted MMH/FH, MA/FH (or MFHBMA) and EMT/MA estimates by two-digit WUC at O and I levels. In addition, design/performance parameters applicable to each system are required. To simplify this task, the user may request the contractor submit a list of design/performance parameters (Table 3.5) in his maintainability proposal volume. Part II identifies system constants applicable to each system. Baseline constants were determined from the system historical data base. Predicted constants must be determined using contractor estimates.

Part III of the worksheet presents the system analysis evaluation procedure. The methodology shows how each maintenance parameter can be calculated for baseline and predicted criteria plus identification of technology improvement factors. Full or partial completion of this part of the worksheet is left to the discretion of the Handbook user. All, or just a few parameters can be calculated depending on the depth of analysis required. See paragraph 5.1.3 for a more detailed procedure on the calculation of system maintenance requirements. The net output from this worksheet will answer the following questions:

1. Are the contractor's estimates in the "ballpark"?
2. How much maintainability improvement, in percent, is the contractor predicting?
3. Do qualitative maintainability features presented in the contractor's proposal substantiate these estimates?

5.1 AIRFRAME/FUSELAGE SYSTEM - WUC 11, 12

Selected Parameters: Empty weight and maximum speed.

Number of Regression Equations Run: 9

Parameters Considered and Rejected: Crew size, maximum take-off weight, combat weight and service ceiling.

Comments: Empty weight and maximum speed at altitude were the two design parameters selected by the regression analysis program as having the greatest effect on Airframe/Fuselage maintenance. Other parameters were considered and rejected because of lower regression correlation or no impact on the data.

Regression analysis showed that as the weight and speed of an aircraft increased, so did the Airframe/Fuselage maintenance requirements. Larger aircraft with higher speeds required more maintenance to airframe structure (corrosion removal) and to access panels (loose/missing fasteners). Surprisingly, the number of ejection seats (crew size) in an aircraft was not a statistically valid parameter.

A satisfactory regression equation could not be obtained using the Fuselage System (WUC 12) alone. As a result, WUC's 11 and 12 were combined.

TABLE 5.1-1 TWO-DIGIT WUC MAINTENANCE DATA SUMMARY

WUC: 11, 12 SYSTEM: Airframe and Fuselage

ACFT	O LEVEL					I LEVEL					TOTAL
	MMH/FH	MA/FH	MMH/MA	EMT/MA	MEN	MMH/FH	MA/FH	MMH/MA	EMT/MA	MEN	MMH/FH
CLASS 1 MAINTENANCE - 3M											
A4M	.400	.081	4.94	2.73	1.8	.022	.005	4.40	3.43	1.3	.422
A6E	1.011	.283	3.56	1.93	1.8	.043	.006	7.13	4.78	1.5	1.054
A-7E	1.071	.233	4.60	2.36	2.0	.151	.007	21.57	13.02	1.7	1.222
AV8A	.741	.125	5.93	3.53	1.7	.005	.003	1.68	0.98	1.7	.746
F4J	2.075	.341	6.09	3.43	1.8	.044	.006	7.33	4.12	1.8	2.119
F8J	1.499	.233	6.43	3.04	2.1	.086	.015	5.73	5.35	1.1	1.585
F14A	1.902	.371	5.13	2.48	2.1	.221	.014	15.79	9.86	1.6	2.123
S3A	.834	.210	3.97	2.14	1.8	.050	.011	4.55	3.13	1.5	.884
CLASS 3 MAINTENANCE - DESIGN EQUIVALENT											
A4M	.203	.054	3.76	1.90	2.0	.015	.005	3.13	2.48	1.3	.219
A6E	.554	.226	2.45	1.29	1.9	.028	.006	4.63	3.37	1.4	.581
A7E	.625	.200	3.13	1.49	2.1	.092	.006	15.32	9.88	1.6	.718
AV8A	.424	.100	4.24	2.33	1.8	.004	.003	1.35	0.80	1.7	.428
F4J	1.161	.284	4.09	2.15	1.9	.028	.006	4.76	2.35	2.0	1.190
F8J	.871	.204	4.27	1.88	2.3	.055	.014	3.94	3.08	1.3	.926
F14A	.951	.273	3.48	1.10	2.2	.120	.013	9.23	6.35	1.5	1.071
S3A	.424	.165	2.55	1.35	1.9	.034	.011	3.06	2.21	1.4	.457

TABLE 5.1-2 REGRESSION ANALYSIS SUMMARY

WUC: 11, 12 SYSTEM: Airframe/Fuselage

MAINTENANCE INDEX ESTIMATION - MMH/FH O LEVEL

ACFT	3M MI		ERROR	WTMT WEIGHT EMPTY X 10^3 LBS	VMAX MAX SPEED X 10^3 KNOTS
	ACTUAL	CALCULATED			
A4M	.400	.593	-.193	10.4	.537
A6E	1.011	1.037	-.026	26.0	.490
A7E	1.071	.883	.188	18.9	.506
AV8A	.741	.655	.086	12.0	.525
F4J	2.075	1.907	.168	30.8	1.230
F8J	1.499	1.472	.027	19.8	.989
F14A	1.902	2.084	-.182	38.2	1.314
S3A	.834	.901	-.067	26.6	.410

STATISTICAL PARAMETERS:

REGRESSION EQUATION	MI =	-0.2180 + 0.5692 ln (WTMT) +0.8394 ln (VMAX)
CORRELATION COEFFICIENT	r =	0.9686
STANDARD ERROR OF ESTIMATE	S =	0.1717
CONFIDENCE LEVEL, 95%	2S =	0.3434
NUMBER OF OBSERVATIONS	N =	8

FREQUENCY INDEX ESTIMATION - MA/FH O LEVEL

ACFT	3M FI		ERROR	WTMT WEIGHT EMPTY X 10^3 LBS	VMAX MAX SPEED X 10^3 KNOTS
	ACTUAL	CALCULATED			
A4M	.081	.095	-.014	10.4	.537
A6E	.283	.256	.027	26.0	.490
A7E	.233	.200	.033	18.9	.506
AV8A	.125	.120	.005	12.0	.525
F4J	.341	.335	.006	30.8	1.230
F8J	.233	.243	-.010	19.8	.989
F14A	.371	.377	-.006	38.2	1.314
S3A	.210	.250	.040	26.6	.410

STATISTICAL PARAMETERS:

REGRESSION EQUATION	FI =	-0.2931 + 0.1800 ln (WTMT) +0.0525 ln (VMAX)
CORRELATION COEFFICIENT	r =	0.9711
STANDARD ERROR OF ESTIMATE	S =	0.0280
CONFIDENCE LEVEL, 95%	2S =	0.0360
NUMBER OF OBSERVATIONS	N =	8

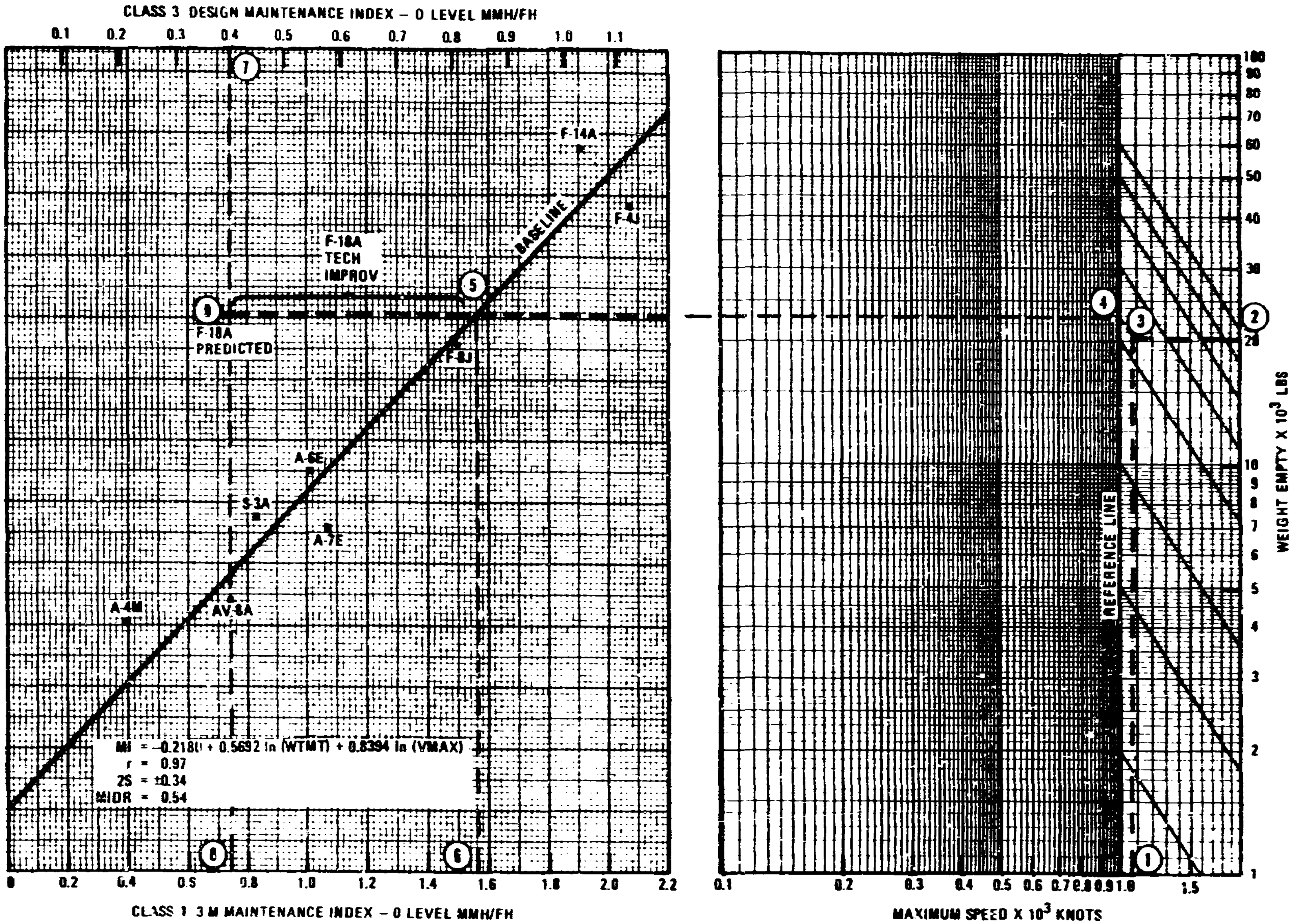


Figure 5.1-1 WUC 11, 12 Maintenance Index Graph

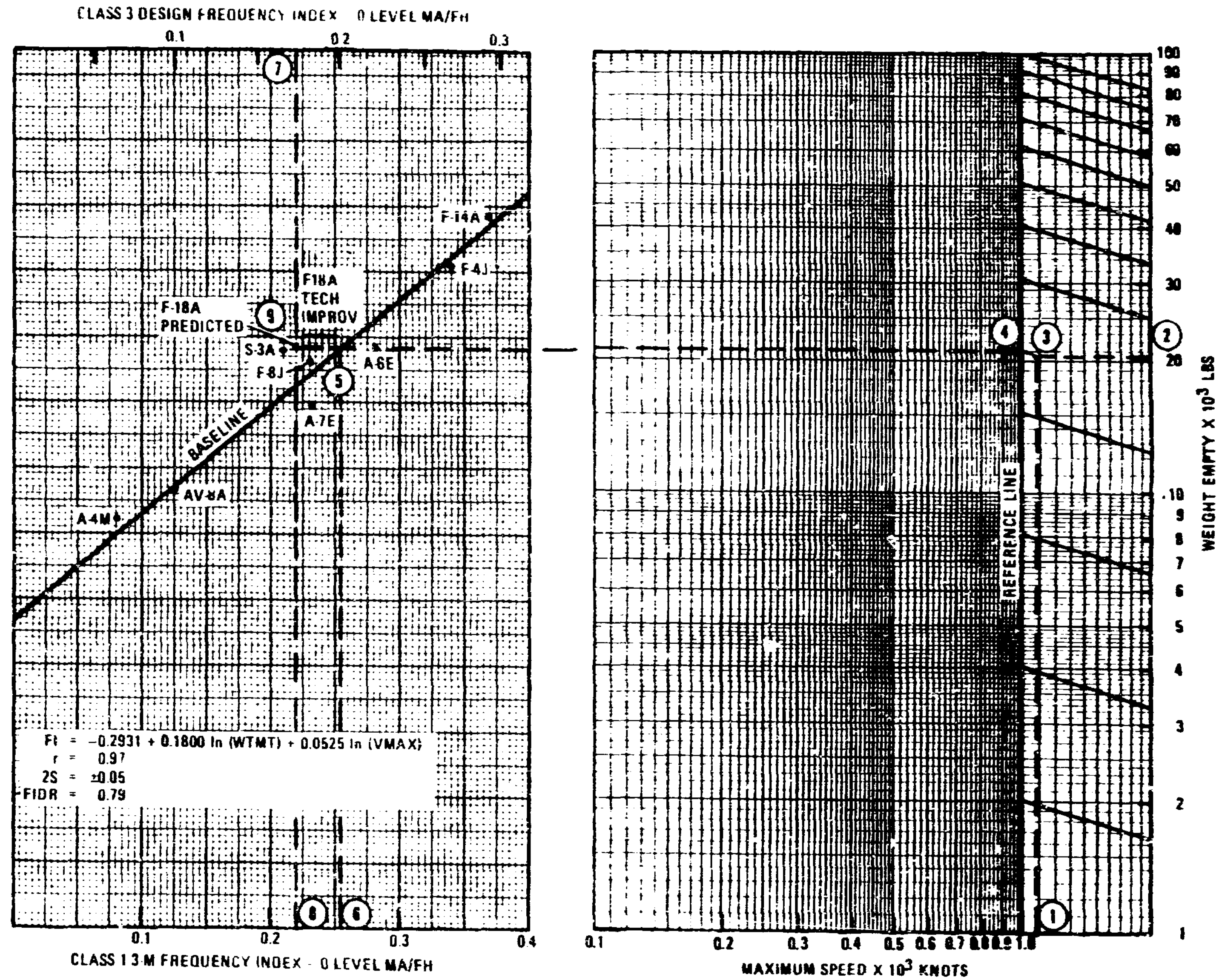


Figure 5.1-2 WUC 11, 12 Frequency Index Graph

5.1.1 Sample Procedure for Evaluating Airframe/Fuselage Maintenance Index* - Figure 5.1-1

STEPS

1** Enter maximum speed of aircraft under analysis on the scale labeled "MAXIMUM SPEED X10^3 KNOTS" (Point 1): 1.085 knots (1,085 knots).

2** Enter weight empty on the scale label "WEIGHT EMPTY X10^3 LBS" (Point 2): 20.583 pounds (20,583 pounds).

3 Draw lines from Point 1 and from Point 2 until they intersect (Point 3).

4 From Point 3, draw a line parallel to the series of diagonal lines on the right side of the graph and intersect the reference line (Point 4).

5 From Point 4, draw a horizontal line to the left intersecting the line labeled "BASELINE" (Point 5). The line represents the state-of-the-art curve for this system. This curve was developed through regression analysis techniques as shown in Table 5.1-2.

6 Drop a vertical line from Point 5 down to the lower scale labeled "3-M MAINTENANCE INDEX - O LEVEL MMH/FH" to determine the baseline 3-M Maintenance Index (Point 6). This point identifies the O-Level MMH/FH expected for the given aircraft using existing state-of-the-art technology and average M effort.

Since this value will be used in worksheet calculations, the user may desire to solve the Maintenance Index (MI) equation shown on the graph for increased accuracy. The answer should be carried to the third decimal point to insure sufficient accuracy in the system evaluation.

$$
\begin{aligned}
MI &= -0.2181 + 0.5692 \ln(WTMT) + 0.8394 \ln(VMAX) \\
&= -0.2181 + 0.5692 \ln(20.583) + 0.8394 \ln(1.085) \\
&= -0.2181 + 0.5692\,(3.024) + 0.8394\,(0.0815) \\
&= 1.572 \text{ MMH/FH}
\end{aligned}
$$

Record the answer or the value from the graph (Point 6) in block A1 of the worksheet (Figure 5.1-3).

7 Enter the contractor's predicted O-LEVEL MMH/FH on the DESIGN MAINTENANCE INDEX scale (Point 7). In this example the value used is 0.403.

8 Drop a vertical line from Point 7 to the lower scale "3-M MAINTENANCE INDEX - O LEVEL MMH/FH" (Point 8).

This point identifies the 3-M equivalent of the contractor's prediction. For system evaluation accuracy, the user may desire to solve the following equation:

$$\text{Predicted 3-M MI} = \frac{\text{Predicted Design MI}}{\text{MIDR}} = \frac{0.403}{0.54}$$

$$= 0.746 \text{ MMH/FH}$$

Where the MIDR is the Maintenance Index Defect Ratio. For this system the MIDR was determined to be 0.54. This means that 54% of the reported 3-M data is considered contractor controllable through design. The remaining 46% is primarily attributed to the no defect and cannibalization maintenance actions plus inherent 3-M delay time, i.e. travel to and from a job, minor maintenance delays, etc.

Record the answer or the value from the graph (Point 8) in block B1 of the worksheet.

Calculate the predicted M Technology Improvement (TI) Index over the baseline design:

$$TI = \frac{\text{Baseline 3-M MI} - \text{Predicted 3-M MI}}{\text{Baseline 3-M MI}} \times 100\%$$

$$= \frac{1.572 - 0.746}{1.572} \times 100\% = 53\%$$

A method to graphically portray the TI is to extend the line connecting Points 4 and 5 until it intersects the line connecting Points 7 and 8. The distance between this intersection (Point 9) and Point 5 identifies the predicted improvement over baseline design.

*Example shows F-18A estimates.
**Some WUC systems require an entry of only one parameter.

5.1.2 Sample Procedure for Evaluating Airframe/Fuselage Frequency Index* - Figure 5.1-2

STEPS

1** Enter maximum speed of aircraft under analysis on the scale labeled "MAXIMUM SPEED X10^3 KNOTS" (Point 1): 1.085 knots (1,085 knots).

2** Enter weight empty on the scale label "WEIGHT EMPTY X10^3 LBS" (Point 2): 20.583 pounds (20,583 pounds).

3 Draw lines from Point 1 and from Point 2 until they intersect (Point 3).

4 From Point 3, draw a line parallel to the series of diagonal lines on the right side of the graph and intersect the reference line (Point 4).

5 From Point 4, draw a horizontal line to the left intersecting the line labeled "BASELINE" (Point 5). The line represents the state-of-the-art curve for this system. This curve was developed through regression analysis techniques as shown in Table 5.1-2.

6 Drop a vertical line from Point 5 down to the lower scale labeled "3-M FREQUENCY INDEX - O LEVEL MA/FH" to determine the baseline 3-M Frequency Index (Point 6). This point identifies the O-Level MA/FH expected for the given aircraft using existing state-of-the-art technology and average M effort.

Since this value will be used in worksheet calculations, the user may desire to solve the Frequency Index (FI) equation shown on the graph for increased accuracy. The answer should be carried to the third decimal point to insure sufficient accuracy in the system evaluation.

$$
\begin{aligned}
FI &= -0.2931 + 0.1800 \ln (WTMT) + 0.0525 \ln (VMAX) \\
&= -0.2931 + 0.1800 \ln (20.583) + 0.0525 \ln (1.085) \\
&= -0.2931 + 0.1800 (3.024) + 0.0525 (0.0815) \\
&= 1.256 \text{ MA/FH}
\end{aligned}
$$

Record the answer or the value from the graph (Point 6) in block A2 of the worksheet (Figure 5.1-3).

7 Enter the contractor's predicted O LEVEL MA/FH on the DESIGN FREQUENCY INDEX scale (Point 7). In this example the value used is 0.176.

8 Drop a vertical line from Point 7 to the lower scale "3-M FREQUENCY INDEX - O LEVEL MA/FH" (Point 8).

This point identifies the 3-M equivalent of the contractor's prediction. For system evaluation accuracy, the user may desire to solve the following equation:

$$\text{Predicted 3-M FI} = \frac{\text{Predicted Design FI}}{\text{FIDR}} = \frac{0.176}{0.79}$$

$$= 0.223 \text{ MA/FH}$$

Where the FIDR is the Frequency Index Defect Ratio. For this system the FIDR was determined to be 0.79. This means that 79% of the reported 3-M data is considered contractor controllable through design. The remaining 21% is primarily attributed to the no defect cannibalization, and missing fastener maintenance actions.

Record the answer or the value from the graph (Point 8) in block B1 of the worksheet.

Calculate the predicted M Technology Improvement (TI) Index over the baseline design:

$$TI = \frac{\text{Baseline 3-M FI} - \text{Predicted 3-M FI}}{\text{Baseline 3-M FI}} \times 100\%$$

$$= \frac{0.256 - 0.223}{0.256} \times 100\% = 13\%$$

A method to graphically portray the TI is to extend the line connecting Points 4 and 5 until it intersects the line connecting Points 7 and 8. The distance between this intersection (Point 9) and Point 5 identifies the predicted improvement over baseline design.

*Example shows F-18A estimates.
**Some WUC systems require an entry of only one parameter.

5.1.3 Sample Procedure For Evaluating System Maintenance Requirements

A worksheet is provided for use in evaluating system quantitative maintenance estimates for a new design (Figure 5.1-3). The worksheet is divided into three parts to simplify its use. Sample calculations and instructions for filling out the worksheet are shown below.

WORKSHEET PART I. CONTRACTOR DATA

Extract the following estimate from the contractor's maintainability proposal: MMH/FH, MA/FH (converted from MFHBMA) and EMT/MA (MTTR) for both O and I levels. Compute MMH/MA at O and I levels and record values in appropriate blocks, i.e.

$$MMH/MA_O = \frac{MMH/FH_O}{MA/FH_O} = \frac{0.403}{0.176} = 2.29$$

To provide consistency throughout the evaluation, calculations should be rounded off to the first digit for MEN, to the second digit for MMH/MA and EMT/MA and to the third digit for MMH/FH and MA/FH. This was the procedure used in deriving the Maintainability Index Model.

Fill in the "Design/Performance Parameters" box with contractor estimates.

WORKSHEET PART II. SYSTEM CONSTANTS

System constants are used to complete Part III of the worksheet. Baseline constants were determined from the system historical data base. Predicted constants must be determined using contractor estimates:

MEN_O = Average number of Men per Maintenance Action at O-level

$$= \frac{MMH\ MA_O}{EMT\ MA_O} = \frac{2.29}{1.43} = 1.6$$

MEN_I = Average number of Men per Maintenance Action at I-level

$$= \frac{MMH/MA_I}{EMT/MA_I} = \frac{1.92}{0.72} = 2.7$$

MIIR = Maintenance Index I-Level Ratio

$$= \frac{MMH/FH_I}{MMH/FH_O} = \frac{0.121}{0.403} = 0.30$$

FIIR = Frequency Index I-Level Ratio

$$= \frac{MA/FH_I}{MA/FH_O} = \frac{0.063}{0.176} = 0.36$$

WORKSHEET PART III. SYSTEM ANALYSIS

Part III presents the system analysis evaluation procedure. Contractor "design-to" predictions are converted to a 3-M equivalent in order to make a valid comparison with baseline data. This procedure requires that selected maintenance parameters be calculated for three categories:

A. Baseline Class 1 3-M Data identifies the minimum acceptable maintenance expenditure for the given design as measured in an operational environment. These values are determined by the Maintainability Index Model.

B. Predicted Class 1 3-M Data identifies the 3-M equivalent of the contractor's prediction. These values are determined by using MI and FI graphs and general mathematical relationships.

C. Technology Improvement (Degradation) identifies the predicted improvement or degradation over a baseline design using Class 1 estimates. Two values are determined: a delta (Δ) difference and a percent change.

To facilitate computations, an alpha-numeric symbol is assigned to each calculation. For example, calculation B4 identifies predicted Class 1 3-M EMT/MA at O-level.

1. MMH/FH O-Level. Using the "Design and Performance Parameters" of Part I, complete the Maintenance Index Graph (Figure 5.1-1). Three MMH/FH values from this graph are required for use in the worksheet. Pertinent calculations using alpha-numeric symbols are repeated below.

A1 = Solution of the MI equation (Point 6 on the graph)
= -0.2181 + 0.5692 ln (WTMT) + 0.8394 ln (VMAX)
= -0.2181 + 0.5692 ln (20.583) + 0.8394 ln (1.085)
= 1.572

B1 = 3-M equivalent of the contractor's prediction (Point 8 on the graph)

$$= \frac{\text{Design MI}}{\text{MIDR}} = \frac{0.403}{0.54} = 0.746$$

Where Design MI is Point 7 on the graph

$$C1_{\Delta} = | A1 - B1 | = | 1.572 - 0.746 | = 0.826$$

$$C1_{\%} = \frac{C1_{\Delta}}{A1} \times 100\% = \frac{0.826}{1.572} \times 100\% = 53\%$$

2. MA/FH O-Level. Using the "Design and Performance Parameters" of Part I, complete the Frequency Index Graph (Figure 5.1-2). Three MA/FH values from this graph are required for use in the worksheet. Pertinent calculations are shown below.

A2 = Solution of the FI equation (Point 6 on the graph)
= -0.2931 + 0.1800 ln (WTMT) + 0.0525 ln (VMAX)
= -0.2931 + 0.1800 ln (20.583) + 0.0525 ln (1.085)
= 0.256

B2 = 3-M equivalent of the contractor's prediction (Point 8 on the graph)

$$= \frac{\text{Design FI}}{\text{FIDR}} = \frac{0.176}{0.79} = 0.223$$

Where Design FI is Point 7 on the graph

$$C2_{\Delta} = | A2 - B2 | = | 0.256 - 0.223 | = 0.033$$

$$C2_{\%} = \frac{C2_{\Delta}}{A2} \times 100\% = \frac{0.033}{0.256} \times 100\% = 13\%$$

3. MMH/MA O-Level. System repair time measured in MMH/MA at O-level is determined by dividing MMH/FH by MA/FH for both baseline and predicted Class 1 data categories. Spaces are provided on the worksheet for calculations and answers.

$$A3 = \frac{A1}{A2} = \frac{1.572}{0.256} = 6.14$$

$$B3 = \frac{B1}{B2} = \frac{0.746}{0.233} = 3.35$$

$$C3_{\Delta} = | A3 - B3 | = | 6.14 - 3.35 | = 2.79$$

$$C3_{\%} = \frac{C3_{\Delta}}{A3} \times 100\% = \frac{2.79}{6.14} \times 100\% = 45\%$$

4. EMT/MA O-Level. System repair time measured in EMT/MA at O-level is determined by dividing MMH/MA by the average number of men per unscheduled maintenance action. For the baseline category, use baseline system constant MEN_O. For the predicted category, use predicted constant MEN_O as listed in Part II.

$$A4 = \frac{A3}{\text{BASE } MEN_O} = \frac{6.14}{1.9} = 3.23$$

$$B4 = \frac{B3}{\text{PRED } MEN_O} = \frac{3.35}{1.6} = 2.09$$

$$C4_\Delta = |\ A4 - B4\ | = |3.23 - 2.09\ | = 1.14$$

$$C4_\% = \frac{C4_\Delta}{A4} \times 100\% = \frac{1.14}{3.23} \times 100\% = 35\%$$

5. MMH/FH I-Level. System analysis for this parameter is determined by multiplying MMH/FH_O by the appropriate I-Level Ratio (ILR) shown in Part II.

$$A5 = A1 \times \text{BASE MIIR}$$
$$= 1.572 \times 0.04 = 0.063$$

$$B5 = B1 \times \text{PRED MIIR}$$
$$= 0.746 \times 0.30 = 0.224$$

$$C5_\Delta = |\ A5 - B5\ | = |\ 0.063 - 0.224\ | = 0.161$$

$$C5_\% = \frac{C5_\Delta}{A5} \times 100\% = \frac{0.161}{0.063} \times 100\% = 256\%$$

Example shows contractor predicted MIIR (0.30) is higher than the baseline MIIR (0.04). This results in a higher expenditure of maintenance at I-level than the baseline design shows. Hence, both C5 values are entered on the worksheet in parentheses to signify system degradation for MA/FH at I-level.

6. MA/FH I-Level. System analysis for this parameter is completed in similar fashion as MMH/FH_I using system constant FIIR

7. MMH/MA I-Level. System repair time measured in MMH/MA at I-level is determined by dividing MMH/FH_I by MA/FH_I for both baseline and predicted Class 1 data categories.

8. EMT/MA I-Level. System repair time measured in EMT/MA at I-level is determined by dividing MMH/MA_I by the average number of men per maintenance action, MEN_I.

9. MMH/FH O and I Levels. Add O and I values by category to determine total unscheduled system MMH/FH. Calculate improvement (degradation).

10. COMMENTS:

Upon completion of the worksheet the following questions should be asked: (1) Are the contractor's estimates in the "ballpark"? (2) How much improvement is the contractor predicting? (3) Do qualitative R&M features presented in the contractor's proposal substantiate these estimates? What are the areas of concern in the analysis?

A typical response using this system as an example might be: Overall, the contractor's predictions are in the "ballpark". A 41% (0.665 MMH/FH) improvement would appear reasonable depending on R&M features called out in the proposal. Areas of concern include a 45% improvement in repair time (MMH/MA_O), but only a 13% improvement in frequency of maintenance (MA/FH_O). Normally, frequency has more effect on maintenance (MMH/FH) than repair time. A second concern might be the higher expenditure of maintenance at I-level (0.161 MMH/FH) than a baseline design.

WUC: 11.12 CONTRACTOR: McDonnell

SYSTEM: Airframe/Fuselage AIRCRAFT MODEL: F-18A

PART I CONTRACTOR DATA

CONTRACTOR PREDICTIONS – CLASS 3 DESIGN MAINT. REQ.				
ML	MMH/FH	MA/FH	MMH/MA	EMT/MA
O	.403	.176	2.29	1.43
I	.121	.063	1.92	0.72

DESIGN/PERFORMANCE PARAMETERS	
Weight Empty, lbs	20,583
Max. speed, knots	1,085

PART II SYSTEM CONSTANTS

PARAMETER		BASE	PRED
MEN_O	AVG NO. MEN – O LEVEL	1.9	1.6
MEN_I	AVG NO. MEN – I LEVEL	1.7	2.7
MIIR	MMH/FH I LEVEL RATIO	.04	.30
FIIR	MA/FH I LEVEL RATIO	.07	.36

PART III SYSTEM ANALYSIS

PARAMETER	CALCULATION	BASELINE CLASS 1 3-M DATA (A)	PREDICTED CLASS 1 3-M DATA (B)	IMPROVEMENT (DEGRADATION) (C) Δ	%
MMH/FH_O (1)	MAINT INDEX GRAPH				
	BASELINE	1.572		.826	53%
	PREDICTED		.746		
MA/FH_O (2)	FREQ INDEX GRAPH				
	BASELINE	.256		.033	13%
	PREDICTED		.223		
MMH/MA_O (3)	$MMH/FH_O \div MA/FH_O$				
	1.572 ÷ .256	6.14		2.79	45%
	.746 ÷ .223		3.35		
EMT/MA_O (4)	$MMH/MA_O \div MEN_O$				
	6.14 ÷ 1.9	3.23		1.14	35%
	3.35 ÷ 1.6		2.09		
MMH/FH_I (5)	$MMH/FH_O \times MIIR$				
	1.572 × .04	.063		(.161)	(256%)
	.746 × .30		.224		
MA/FH_I (6)	$MA/FH_O \times FIIR$				
	.256 × .07	.018		(.062)	(344%)
	.223 × .36		.080		
MMH/MA_I (7)	$MMH/FH_I \div MA/FH_I$				
	.063 ÷ .018	3.50		0.70	20%
	.224 ÷ .080		2.80		
EMT/MA_I (8)	$MMH/MA_I \div MEN_I$				
	3.50 ÷ 1.7	2.06		1.02	50%
	2.80 ÷ 2.7		1.05		
$MMH/FH_{O,I}$ (9)	$MMH/FH_O + MMH/FH_I$	1.635	.970	.665	41%

FIGURE 5.1-3 Worksheet for Evaluating System Maintenance Requirements

WUC: 11, 12 CONTRACTOR: ______

SYSTEM: Airframe/Fuselage AIRCRAFT MODEL: ______

PART I CONTRACTOR DATA

CONTRACTOR PREDICTIONS – CLASS 3 DESIGN MAINT. REQ.				
ML	MMH/FH	MA/FH	MMH/MA	EMT/MA
O				
I				

DESIGN/PERFORMANCE PARAMETERS	
Weight empty, lbs.	
Max. speed, knots	

PART II SYSTEM CONSTANTS

PARAMETER		BASE	PRED
MEN_O	AVG NO. MEN – O LEVEL	1.9	
MEN_I	AVG NO. MEN – I LEVEL	1.7	
MIIR	MMH/FH I LEVEL RATIO	.04	
FIIR	MA/FH I LEVEL RATIO	.07	

PART III SYSTEM ANALYSIS

PARAMETER	CALCULATION	BASELINE CLASS 1 3-M DATA (A)	PREDICTED CLASS 1 3-M DATA (B)	IMPROVEMENT (DEGRADATION) (C) Δ	%
MMH/FH_O (1)	MAINT INDEX GRAPH				
	BASELINE				
	PREDICTED				
MA/FH_O (2)	FREQ INDEX GRAPH				
	BASELINE				
	PREDICTED				
MMH/MA_O (3)	$MMH/FH_O \div MA/FH_O$				
	÷				
	÷				
EMT/MA_O (4)	$MMH/MA_O \div MEN_O$				
MMH/FH_I (5)	MMH/FH_O X MIIR				
	X				
	X				
MA/FH_I (6)	MA/FH_O X FIIR				
	X				
	X				
MMH/MA_I (7)	$MMH/FH_I \div MA/FH_I$				
	÷				
	÷				
EMT/MA_I (8)	$MMH/MA_I \div MEN_I$				
	÷				
$MMH/FH_{O,I}$ (9)	$MMH/FH_O + MMH/FH_I$				

FIGURE 5.1-4 Worksheet for Evaluating System Maintenance Requirements

5.2 LANDING GEAR SYSTEM - WUC 13

Selected Parameters: Landing weight and kinetic energy.

Number of Regression Equations Run: 13

Parameters Considered and Rejected: Empty weight, maximum takeoff weight and minimum landing speed.

Comments: The two design parameters that have the greatest influence on Landing Gear System maintenance were landing weight and kinetic energy. Landing weight was selected by the regression analysis program for the Maintenance Index equation while kinetic energy was selected for the Frequency Index equation. Only one parameter was needed in each equation. The addition of a second parameter had no appreciable impact on improving the correlation coefficients.

Higher landing weights and higher values of kinetic energy inherently result in more maintenance expenditure on tires, brakes and other landing gear subsystems. Exact system relationships are shown graphically in Figures 5.2-1 and 5.2-2.

The design parameter kinetic energy is a function of landing weight and minimum carrier approach speed: $KE = WTLAND \times VMIN^2$. Units are in pounds - $knots^2$.

The AV-8A was excluded from this analysis because the selected parameters do not apply to V/STOL aircraft. However, a review of AV-8A historical data (Table 5.2-1) shows no adverse trends in maintenance expenditure.

TABLE 5.2-1 TWO-DIGIT WUC MAINTENANCE DATA SUMMARY

WUC: 13 SYSTEM: Landing Gear

ACFT	CLASS 1 MAINTENANCE - 3M										
	O LEVEL					I LEVEL					TOTAL
	MMH/FH	MA/FH	MMH/MA	EMT/MA	MEN	MMH/FH	MA/FH	MMH/MA	EMT/MA	MEN	MMH/FH
A4M	.510	.154	3.31	1.55	2.1	.343	.086	3.96	2.17	1.8	.853
A6E	.741	.147	5.04	2.22	2.3	.221	.050	4.42	2.87	1.5	.962
A7E	.667	.177	3.80	1.86	2.0	.222	.070	3.17	2.30	1.4	.889
AV8A	.657	.156	4.21	2.16	1.9	.410	.091	4.53	2.43	1.9	1.067
F4J	.994	.227	4.17	2.07	2.0	.500	.119	4.18	2.40	1.7	1.444
F8J	.808	.230	3.51	1.88	1.9	.365	.125	2.93	1.96	1.5	1.173
F14A	1.351	.227	5.93	2.31	2.6	.497	.080	6.17	3.89	1.6	1.848
S3A	.856	.227	3.76	1.77	2.1	.333	.089	3.72	2.59	1.4	1.189
	CLASS 3 MAINTENANCE - DESIGN EQUIVALENT										
A4M	.288	.134	2.15	1.05	2.0	.238	.086	2.76	1.56	1.9	.526
A6E	.367	.115	3.19	1.35	2.3	.148	.048	3.07	2.06	1.5	.514
A7E	.356	.150	2.38	1.15	2.0	.155	.068	2.28	1.65	1.4	.511
AV8A	.360	.132	2.72	1.34	1.9	.277	.089	3.11	1.74	1.9	.637
F4J	.532	.204	2.61	1.28	2.0	.344	.118	2.91	1.73	1.8	.876
F8J	.465	.211	2.02	1.70	1.8	.261	.123	2.12	1.43	1.5	.726
F14A	.599	.169	3.55	1.37	2.6	.324	.078	4.16	2.69	1.6	.924
S3A	.414	.178	2.32	1.10	2.1	.228	.087	2.62	1.84	1.4	.642

TABLE 5.2-2 REGRESSION ANALYSIS SUMMARY

WUC: 13 SYSTEM: Landing Gear

MAINTENANCE INDEX ESTIMATION - MMH/FH O LEVEL

ACFT	3M MI		ERROR	WEIGHT LANDING X 10^3 LBS (WTLAND)	
	ACTUAL	CALCULATED			
A4M	.510	.472	.018	12.4	
A6E	.741	.864	-.123	28.7	
A7E	.667	.681	-.014	21.1	
F4J	.944	1.028	-.084	35.5	
F8J	.808	.715	.093	22.5	
F14A	1.351	1.247	.104	44.6	
S3A	.856	.869	-.013	28.9	

STATISTICAL PARAMETERS:

REGRESSION EQUATION	MI =	0.1738+0.0241(WTLAND)
CORRELATION COEFFICIENT	r =	0.9470
STANDARD ERROR OF ESTIMATE	S =	0.0933
CONFIDENCE LEVEL, 95%	2S =	±0.1866
NUMBER OF OBSERVATIONS	N =	7

FREQUENCY INDEX ESTIMATION - MA/FH O LEVEL

ACFT	3M FI		ERROR	KINETIC ENERGY X 10^9 LBS-KTS^2 (KE)	
	ACTUAL	CALCULATED			
A4M	.154	.141	.013	.209	
A6E	.147	.166	-.019	.347	
A7E	.177	.177	.000	.408	
F4J	.227	.223	.004	.656	
F14A	.227	.225	.002	.664	

STATISTICAL PARAMETERS:

REGRESSION EQUATION	FI =	0.1019 + 0.1850(KE)
CORRELATION COEFFICIENT	r =	0.9517
STANDARD ERROR OF ESTIMATE	S =	0.0137
CONFIDENCE LEVEL, 95%	2S =	±0.0274
NUMBER OF OBSERVATIONS	N =	5

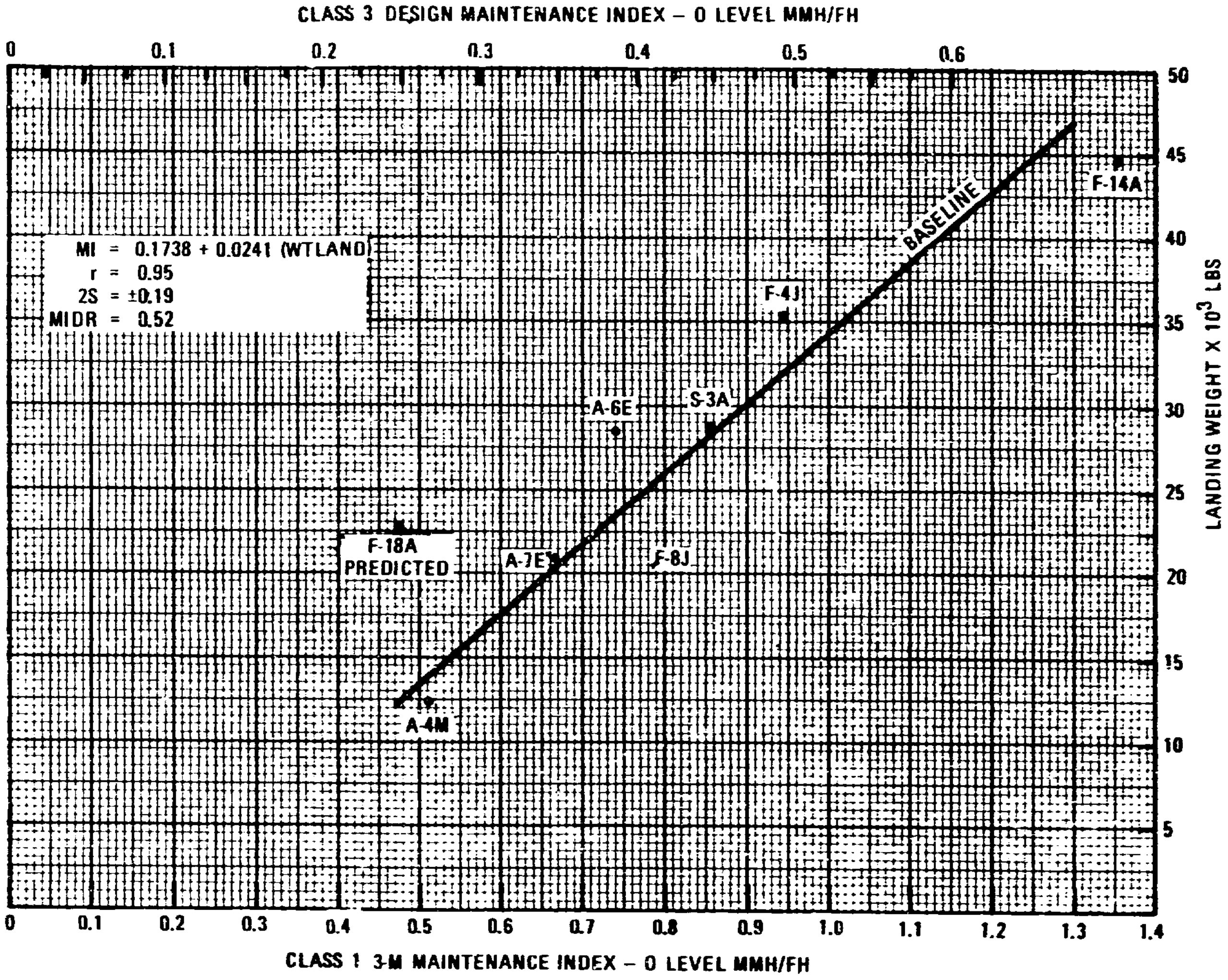


Figure 5.2-1 WUC 13 Maintenance Index Graph

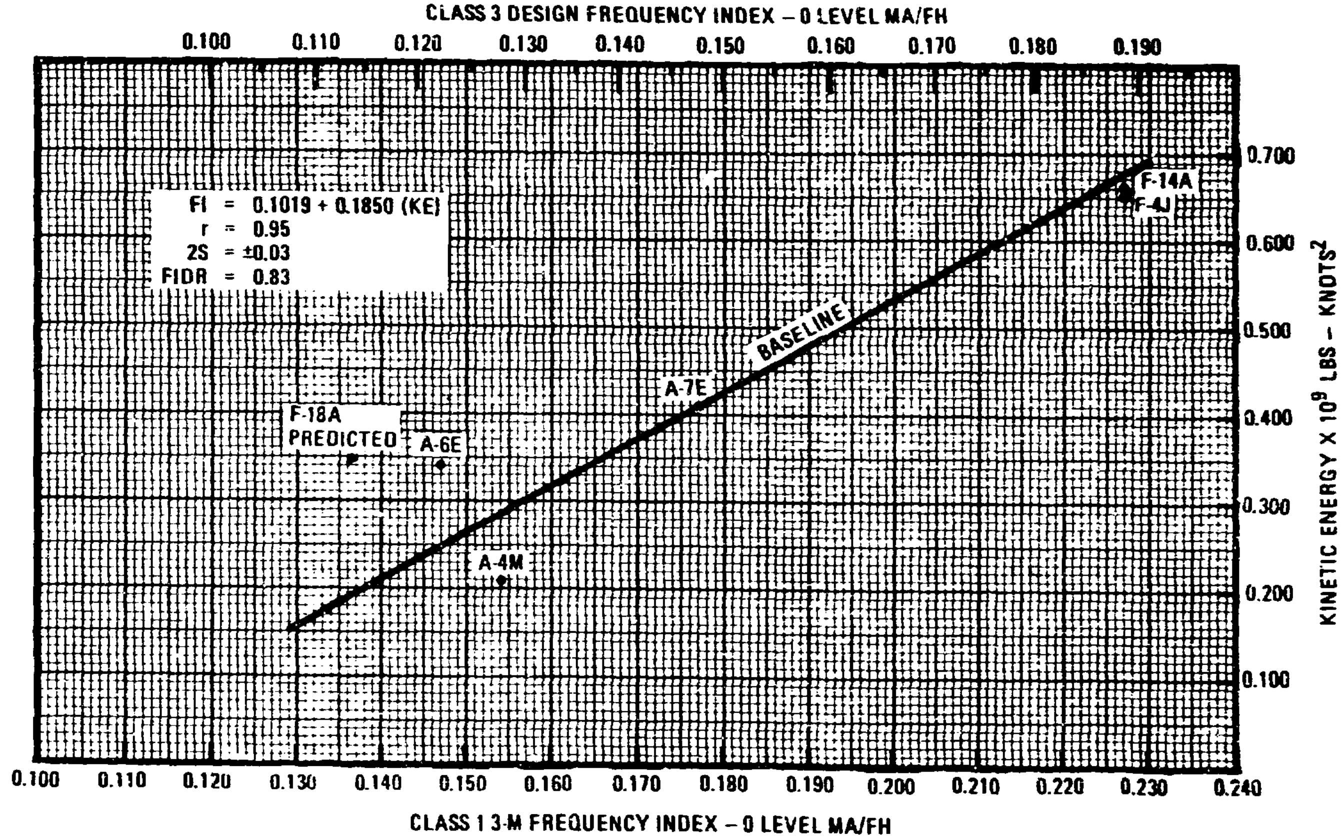


Figure 5.2-2 WUC 13 Frequency Index Graph

WUC: 13 CONTRACTOR: ______
SYSTEM: Landing Gear AIRCRAFT MODEL: ______

PART I CONTRACTOR DATA

CONTRACTOR PREDICTIONS – CLASS 3 DESIGN MAINT. REQ.				
ML	MMH/FH	MA/FH	MMH/MA	EMT/MA
O				
I				

DESIGN/PERFORMANCE PARAMETERS	
Weight Landing, lbs Kinetic Energy, lb - kt^2	

PART II SYSTEM CONSTANTS

PARAMETER		BASE	PRED
MEN_O	AVG NO. MEN – O LEVEL	2.1	
MEN_I	AVG NO. MEN – I LEVEL	1.6	
MIIR	MMH/FH I LEVEL RATIO	.43	
FIIR	MA/FH I LEVEL RATIO	.44	

PART III SYSTEM ANALYSIS

PARAMETER	CALCULATION	BASELINE CLASS 1 3-M DATA (A)	PREDICTED CLASS 1 3-M DATA (B)	IMPROVEMENT (DEGRADATION) (C) Δ	%
MMH/FH_O (1)	MAINT INDEX GRAPH				
	BASELINE				
	PREDICTED				
MA/FH_O (2)	FREQ. INDEX GRAPH				
	BASELINE				
	PREDICTED				
MMH/MA_O (3)	$MMH/FH_O \div MA/FH_O$				
	÷				
EMT/MA_O (4)	$MMH/MA_O \div MEN_O$				
	÷				
	÷				
MMH/FH_I (5)	$MMH/FH_O \times MIIR$				
	X				
	X				
MA/FH_I (6)	$MA/FH_O \times FIIR$				
	X				
	X				
MMH/MA_I (7)	$MMH/FH_I \div MA/FH_I$				
	÷				
	÷				
EMT/MA_I (8)	$MMH/MA_I \div MEN_I$				
	÷				
	÷				
$MMH/FH_{O,I}$ (9)	$MMH/FH_O + MMH/FH_I$				

FIGURE 5.2-3 Worksheet for Evaluating System Maintenance Requirements

5.3 FLIGHT CONTROLS SYSTEM - WUC 14

Selected Parameters: Maximum speed and empty weight. Index constants were established for wing sweep.

Number of Regression Equations Run: 12

Parameters Considered and Rejected: Empty weight and maximum takeoff weight.

Comments: Regression analysis showed that supersonic fighter aircraft tend to require from two to three times the maintenance over subsonic attack aircraft. One reason for this trend is the more complex flight control system used in high performance aircraft.

The S-3A was not used due to poor regression correlation. This was due to the comparatively low maximum speed of the aircraft and higher than normal maintenance for the weight of the aircraft.

The F-14A was the only aircraft with wing sweep. Wing sweep (SWUC 14G) MMH/FH and MA/FH were subtracted from the F-14A totals used in the regression analyses. The F-14A was used in the MMH/FH analysis but eliminated from the MA/FH analysis due to poor correlation.

Index constants of 0.569 MMH/FH and 0.022 MA/FH were established for aircraft with wing sweep. These constants should be added to the regression equation totals.

TABLE 5.3-1 TWO-DIGIT WUC MAINTENANCE DATA SUMMARY

WUC: 14 SYSTEM: Flight Controls

ACFT	CLASS 1 MAINTENANCE - 3M										
	O LEVEL					I LEVEL					TOTAL
	MMH/FH	MA/FH	MMH/MA	EMT/MA	MEN	MMH/FH	MA/FH	MMH/MA	EMT/MA	MEN	MMH/FH
A4M	.272	.065	4.18	2.31	1.8	.017	.006	2.69	2.08	1.3	.291
A6E	.680	.079	8.65	3.96	2.2	.049	.010	5.03	3.64	1.4	.729
A7E	.458	.066	6.95	3.42	2.0	.068	.010	6.50	5.73	1.1	.527
AV8A	.523	.076	6.87	3.71	1.9	.046	.011	4.20	2.98	1.4	.569
F4J	1.199	.154	7.78	3.89	2.0	.110	.016	6.87	4.78	1.4	1.309
F8J	.967	.133	7.27	3.58	2.0	.172	.018	9.55	7.15	1.3	1.139
F14A	2.473	.135	18.42	6.60	2.8	.147	.022	6.63	4.86	1.4	2.620
S3A	1.152	.130	8.85	4.48	2.0	.118	.021	5.59	3.09	1.8	1.270
	CLASS 3 MAINTENANCE - DESIGN EQUIVALENT										
A4M	.136	.050	2.71	1.47	1.8	.012	.006	1.93	1.50	1.3	.147
A6E	.311	.057	5.46	2.31	2.4	.028	.008	3.51	2.62	1.3	.339
A7E	.229	.051	4.50	2.08	2.2	.041	.009	4.61	3.56	1.3	.271
AV8A	.221	.042	5.26	2.59	2.0	.030	.010	2.98	2.16	1.4	.251
F4J	.612	.125	4.89	2.34	2.1	.069	.014	4.92	3.43	1.4	.680
F8J	.510	.107	4.66	2.18	2.1	.106	.016	6.63	5.10	1.3	.616
F14A	.985	.079	12.47	4.14	3.0	.080	.019	4.19	3.10	1.4	1.065
S3A	.444	.066	6.72	3.13	2.1	.078	.021	3.73	2.15	1.7	.522

TABLE 5.3-2 REGRESSION ANALYSIS SUMMARY

WUC: 14 SYSTEM: Flight Controls

MAINTENANCE INDEX ESTIMATION - MMH/FH O LEVEL

ACFT	3M MI		ERROR	WEIGHT EMPTY X 10^3 LBS (WTMT)	MAXIMUM SPEED X 10^3 KNOTS (VMAX)
	ACTUAL	CALCULATED			
A4M	.272	.320	-.048	10.4	.537
A6E	.680	.711	-.031	26.0	.490
A7E	.458	.529	-.071	18.9	.506
AV8A	.523	.355	.168	12.0	.525
F4J	1.199	1.437	-.238	30.8	1.230
F8J	.967	.942	.025	19.8	.989
F14A	1.904 *	1.708	.196	38.2	1.314

STATISTICAL PARAMETERS:

REGRESSION EQUATION	MI =	-0.3963 + 0.0274 (WTMT) +0.8036 (VMAX)
CORRELATION COEFFICIENT	r =	0.9639
STANDARD ERROR OF ESTIMATE	S =	0.1820
CONFIDENCE LEVEL, 95%	2S =	±0.3640
NUMBER OF OBSERVATIONS	N =	7

*Wing Sweep Data Excluded

FREQUENCY INDEX ESTIMATION - MA/FH O LEVEL

ACFT	3M FI		ERROR	MAXIMUM SPEED X 10^3 KNOTS (VMAX)	
	ACTUAL	CALCULATED			
A4M	.065	.075	-.010	.537	
A6E	.079	.069	.010	.490	
A7E	.066	.071	-.005	.506	
AV8A	.076	.073	.003	.525	
F4J	.154	.156	-.002	1.230	
F8J	.133	.128	.005	.989	

STATISTICAL PARAMETERS:

REGRESSION EQUATION	FI =	0.0112 + 0.1183 (VMAX)
CORRELATION COEFFICIENT	r =	0.9823
STANDARD ERROR OF ESTIMATE	S =	0.0080
CONFIDENCE LEVEL, 95%	2S =	±0.0160
NUMBER OF OBSERVATIONS	N =	6

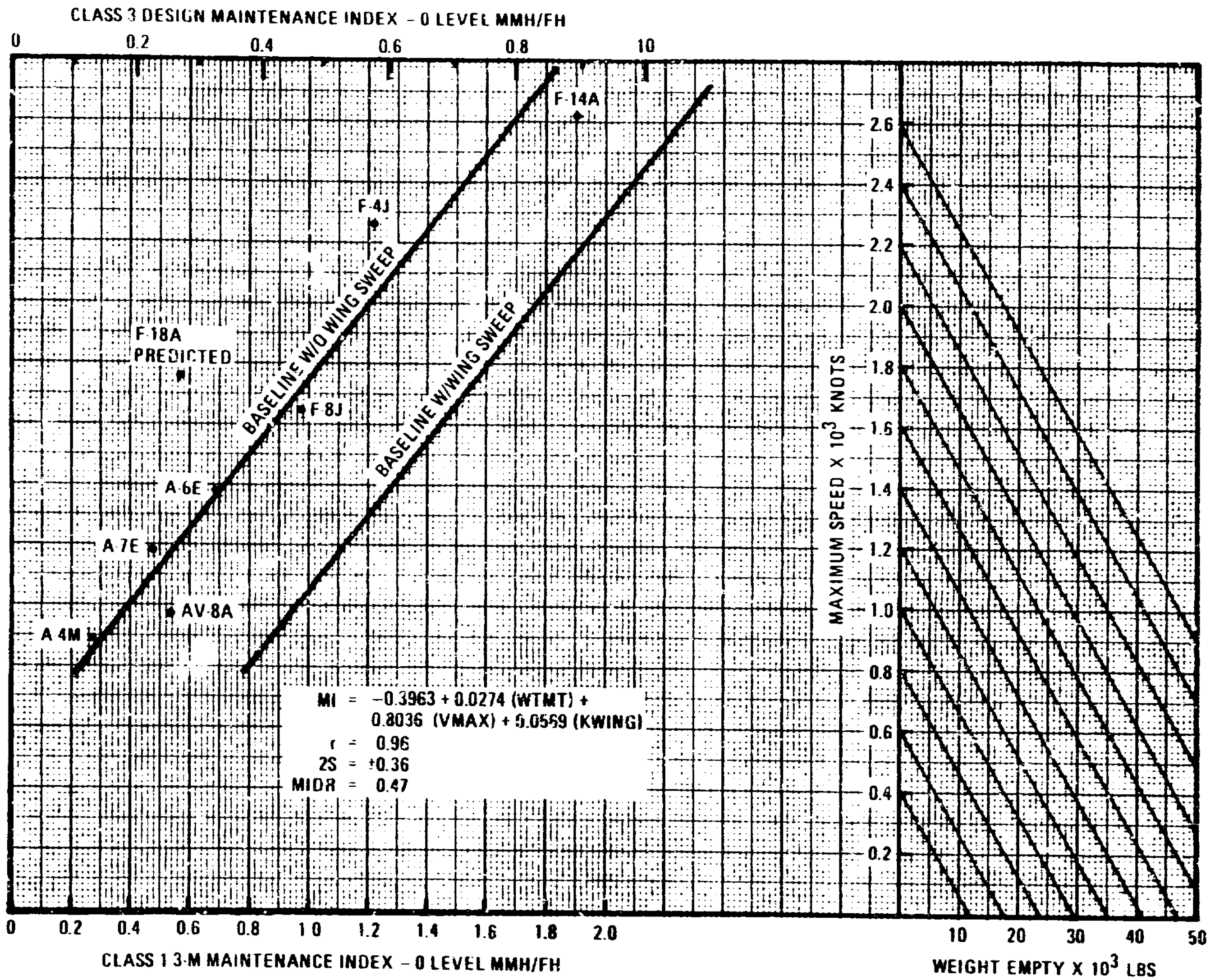


Figure 5.3-1 WUC 14 Maintenance Index Graph

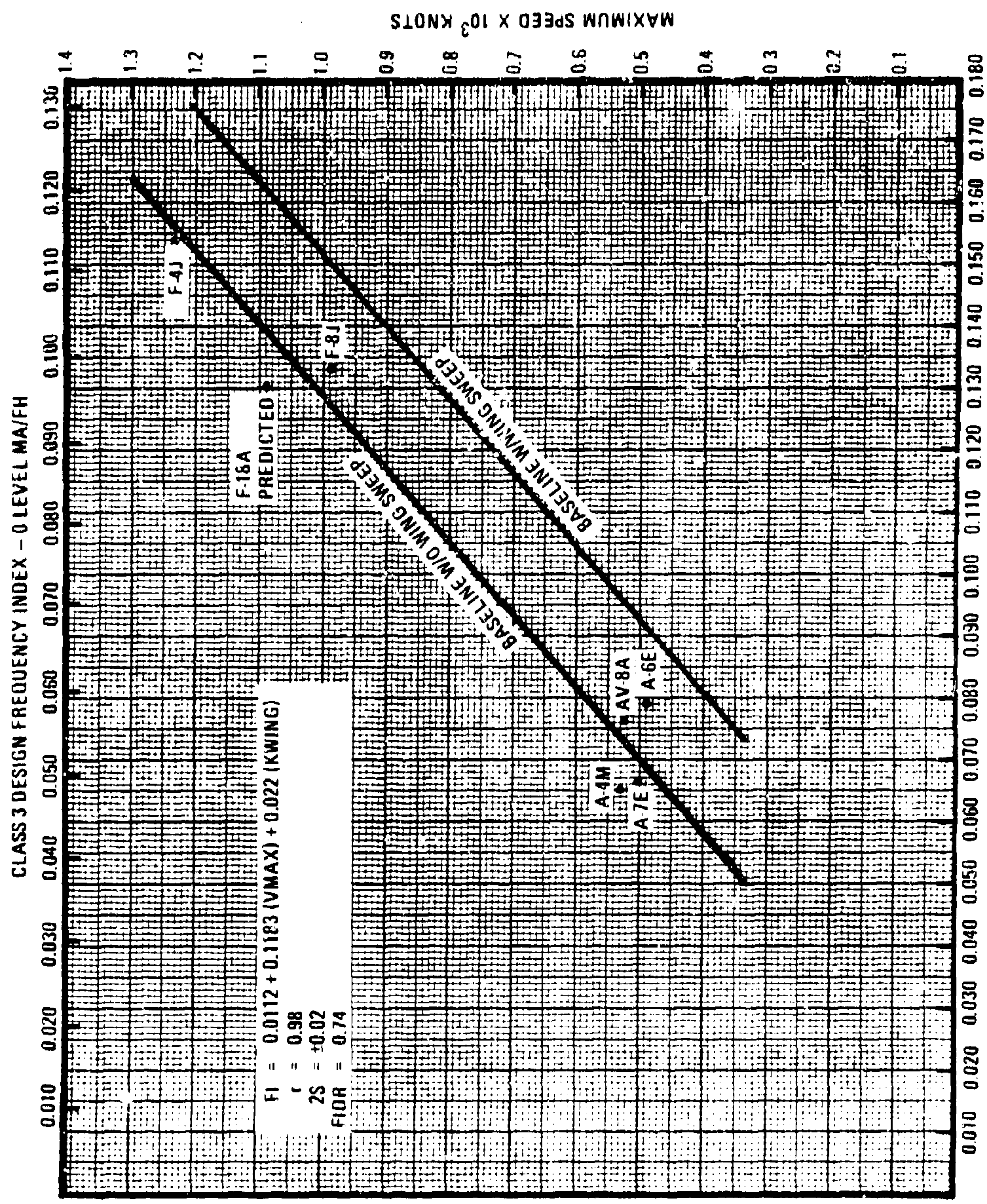


Figure 5.3-2 WUC 14 Frequency Index Graph

WUC: 14	CONTRACTOR:
SYSTEM: Flight Controls	AIRCRAFT MODEL:

PART I CONTRACTOR DATA

CONTRACTOR PREDICTIONS – CLASS 3 DESIGN MAINT. REQ.				
ML	MMH/FH	MA/FH	MMH/MA	EMT/MA
O				
I				

DESIGN/PERFORMANCE PARAMETERS	
Weight Empty, lbs Max. Speed, knots Wing Sweep Factor, 1 or 0	

PART II SYSTEM CONSTANTS

PARAMETER		BASE	PRED
MEN_O	AVG NO. MEN – O LEVEL	2.1	
MEN_I	AVG NO. MEN – I LEVEL	1.3	
MIIR	MMH/FH I LEVEL RATIO	.10	
FIIR	MA/FH I LEVEL RATIO	.13	

PART III SYSTEM ANALYSIS

PARAMETER	CALCULATION	BASELINE CLASS 1 3-M DATA (A)	PREDICTED CLASS 1 3-M DATA (B)	IMPROVEMENT (DEGRADATION) (C) Δ	%
MMH/FH_O (1)	MAINT INDEX GRAPH				
	BASELINE				
	PREDICTED				
MA/FH_O (2)	FREQ INDEX GRAPH				
	BASELINE				
	PREDICTED				
MMH/MA_O (3)	$MMH/FH_O \div MA/FH_O$				
$EMT\ MA_O$ (4)	$MMH/MA_O \div MEN_O$				
MMH/FH_I (5)	$MMH/FH_O \times MIIR$				
	X				
	X				
MA/FH_I (6)	$MA/FH_O \times FIIR$				
	X				
	X				
MMH/MA_I (7)	$MMH/FH_I \div MA/FH_I$				
	÷				
EMT/MA_I (8)	$MMH/MA_I \div MEN_I$				
$MMH/FH_{O,I}$ (9)	$MMH/FH_O + MMH/FH_I$				

FIGURE 5.3-3 Worksheet for Evaluating System Maintenance Requirements

5.4 ENGINE SYSTEM - WUC 23

Selected Parameters: Thrust per engine, uninstalled and number of engines.

Number of Regression Equations Run: 23

Parameters Considered and Rejected: Maximum speed, engine weight, number of compressor stages, maximum takeoff weight and total engine thrust, uninstalled.

Comments: This was the only system for which the 4 to 12 month FMSO baseline data appeared to be inadequate. An acceptable regression equation correlation was not achieved after numerous attempts. Several other data bases were then considered including all FMSO data from July, 1971 through June, 1976. A decision was made to use the period January, 1975 through June, 1976. This period excluded early S-3A and F-14A data which might not be representative for those aircraft. However, the F-8J was phasing out of the fleet during this period and the F-8J engine data was suspect. Consequently, the F-8J was eliminated from the analysis.

Engine data was extracted from the Fleet Weapon System Reliability and Maintainability Statistical Summary (Reference 9) for the selected period. As this data is total O and I, the data was converted to O-level only by using the I-level ratio established by the 4 to 12 month baseline data. F-14A engine data appeared excessively high for all periods. An investigation determined that 65 percent of F-14A maintenance was no defect while the average was 35 percent. The F-14A engine data was adjusted to reflect the average of 35 percent no defect maintenance and then used in the regression analysis.

Single Engine versus Twin Engine: Examination of the maintenance index graph (Figure 5.4-1) reveals some interesting observations about one and two engine aircraft. For high thrust aircraft, a twin engine design is more cost effective from a maintenance standpoint than a single engine design of comparable total thrust. As an example, a twin engine 30,000 pound thrust aircraft using two 15,000 pound engines will require 27% less maintenance (MMH/FH) than a single engine aircraft using one 30,000 pound thrust engine. At the other extreme, a low thrust single engine aircraft requires less maintenance than a low thrust twin engine aircraft. A 10,000 pound thrust single engine aircraft will require 20% less maintenance than a twin engine aircraft with two 5,000 pound thrust engines.

TABLE 5.4-1 TWO-DIGIT WUC MAINTENANCE DATA SUMMARY

WUC: 23 SYSTEM: Engine

ACFT	O LEVEL					I LEVEL					TOTAL
	MMH/FH	MA/FH	MMH/MA	EMT/MA	MEN	MMH/FH	MA/FH	MMH/MA	EMT/MA	MEN	MMH/FH
CLASS 1 MAINTENANCE - 3M											
A4M	.402	.041	9.80	3.50	2.8	.180	.021	8.57	3.30	2.6	.582
A6E	.606	.062	9.77	3.76	2.6	.229	.021	10.90	5.45	2.0	.835
A7E	.752	.026	28.92	9.03	3.2	.494	.036	13.72	4.73	2.9	1.246
AV8A	.382	.061	14.46	4.25	3.4	.140	.007	20.00	14.23	1.4	1.022
F4J	1.168	.094	12.42	4.77	2.6	.451	.044	10.25	4.27	2.4	1.619
F8J	1.143	.062	18.43	6.82	2.7	.293	.031	9.45	4.11	2.3	1.436
* F14A	1.228	.095	12.92	4.30	3.0	.463	.025	18.52	6.38	2.9	1.691
S3A	.825	.077	10.71	4.28	2.5	.103	.010	10.30	4.48	2.3	.928
CLASS 3 MAINTENANCE - DESIGN EQUIVALENT											
A4M	.161	.027	5.96	2.05	2.9	.059	.018	3.27	1.56	2.1	.220
A6E	.210	.038	5.53	1.97	2.8	.103	.018	5.72	3.01	1.9	.313
A7E	.323	.017	19.00	5.58	3.4	.257	.030	8.56	3.17	2.7	.580
AV8A	.458	.024	19.08	6.17	3.9	.055	.003	18.33	7.97	2.3	.513
F4J	.479	.057	8.40	3.11	2.7	.189	.028	6.75	2.81	2.4	.668
F8J	.480	.045	10.66	3.68	2.9	.135	.023	5.87	2.67	2.2	.515
F14A	.503	.047	10.70	3.69	2.9	.208	.014	14.85	5.71	2.6	.711
S3A	.280	.043	6.51	2.50	2.6	.059	.009	6.55	2.98	2.2	.339

* F14A no defect maintenance reduced to reflect average.

TABLE 5.4-2 REGRESSION ANALYSIS SUMMARY

WUC: 23 SYSTEM: Engine

MAINTENANCE INDEX ESTIMATION - MMH/FH O LEVEL

ACFT	3M MI		ERROR	THRUST PER ENGINE UNINST. X 10^3 LBS (THRUST)	NUMBER OF ENGINES (ENGQTY)
	ACTUAL	CALCULATED			
A4M	.402	.468	-.066	11.2	1
A6E	.606	.721	-.115	9.3	2
A7E	.752	.646	.106	15.0	1
AV8A	.882	.921	-.039	20.9	1
F4J	1.168	1.123	.045	17.9	2
F14A	1.228	1.263	.035	20.9	2
S3A	.825	.720	.105	9.275	2

STATISTICAL PARAMETERS:

REGRESSION EQUATION MI = -0.3960 + 0.0467 (THRUST) +0.3414 (ENGQTY)

CORRELATION COEFFICIENT r = 0.9555

STANDARD ERROR OF ESTIMATE S = 0.1058

CONFIDENCE LEVEL, 95% 2S = ±0.2116

NUMBER OF OBSERVATIONS N = 7

FREQUENCY INDEX ESTIMATION - MA/FH O LEVEL

ACFT	3M FI		ERROR	THRUST PER ENGINE UNINST. X 10^3 LBS (THRUST)	NUMBER OF ENGINES (ENGQTY)
	ACTUAL	CALCULATED			
A4M	.041	.040	.001	11.2	1
A6E	.062	.070	-.008	9.3	2
AV8A	.061	.063	-.002	20.9	1
F4J	.094	.090	.004	17.9	2
F8J	.062	.060	.002	19.6	1
F14A	.095	.097	-.002	20.9	2
S3A	.077	.070	.007	9.275	2

STATISTICAL PARAMETERS:

REGRESSION EQUATION FI = -0.0194 + 0.0023 (THRUST) +0.0340 (ENGQTY)

CORRELATION COEFFICIENT r = 0.9687

STANDARD ERROR OF ESTIMATE S = 0.0059

CONFIDENCE LEVEL, 95% 2S = ± 0.0118

NUMBER OF OBSERVATIONS N = 7

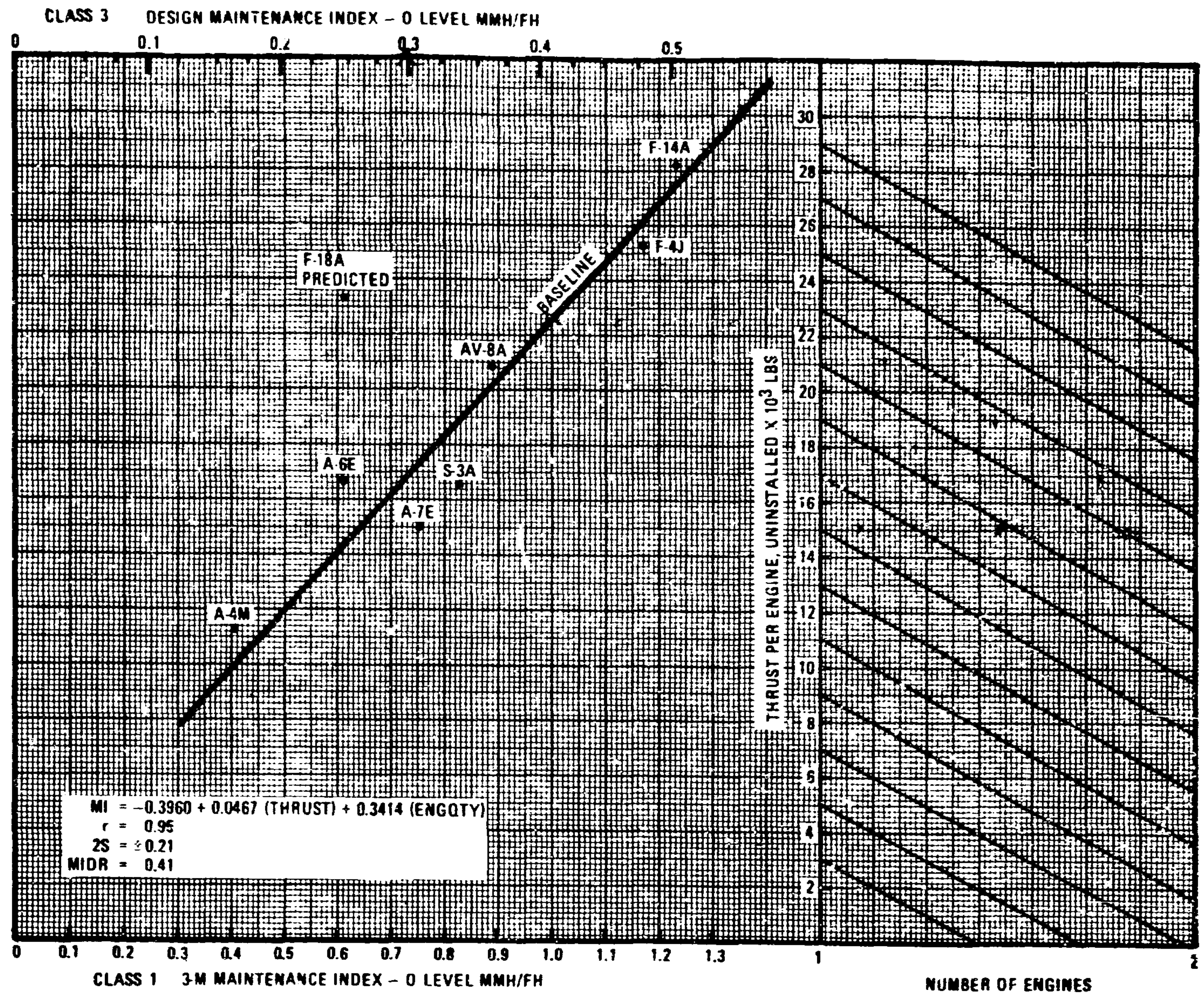


Figure 5-4-1 WUC 23 Maintenance Index Graph

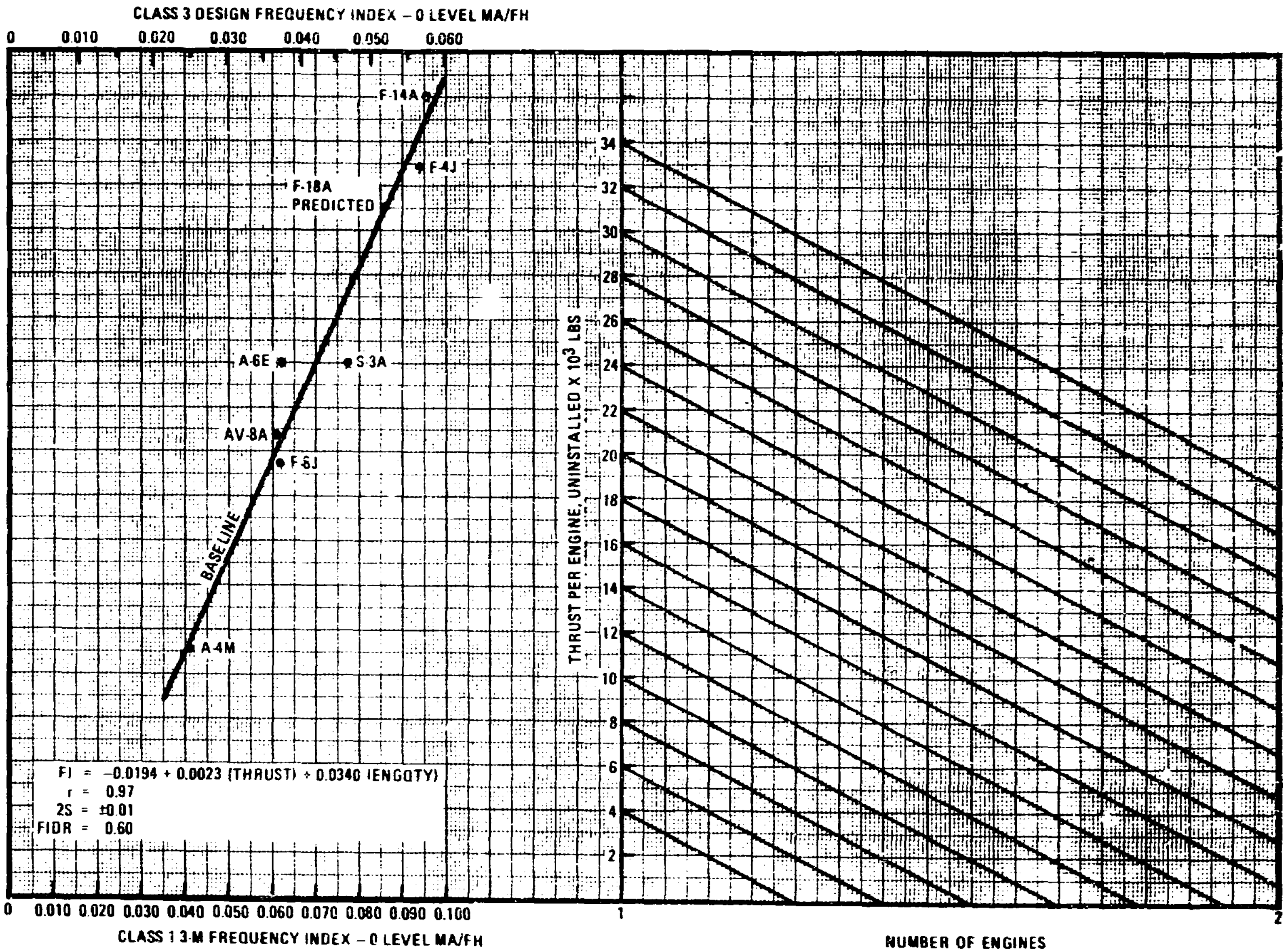


Figure 5.4-2 WUC 23 Frequency Index Graph

WUC: 23 CONTRACTOR: ______

SYSTEM: Engine AIRCRAFT MODEL: ______

PART I CONTRACTOR DATA

CONTRACTOR PREDICTIONS – CLASS 3 DESIGN MAINT. REQ.				
ML	MMH/FH	MA/FH	MMH/MA	EMT/MA
O				
I				

DESIGN/PERFORMANCE PARAMETERS	
Thrust per engine, uninstalled lb Number of engines	

PART II SYSTEM CONSTANTS

PARAMETER		BASE	PRED
MEN_O	AVG NO. MEN O LEVEL	2.9	
MEN_I	AVG NO. MEN I LEVEL	2.3	
MIIR	MMH/FH I LEVEL RATIO	.36	
FIIR	MA/FH I LEVEL RATIO	.33	

PART III SYSTEM ANALYSIS

PARAMETER	CALCULATION	BASELINE CLASS 1 3-M DATA (A)	PREDICTED CLASS 1 3-M DATA (B)	IMPROVEMENT (DEGRADATION) (C) Δ	%
MMH/FH_O (1)	MAINT INDEX GRAPH				
	BASELINE				
	PREDICTED				
MA/FH_O (2)	FREQ. INDEX GRAPH				
	BASELINE				
	PREDICTED				
MMH/MA_O (3)	$MMH/FH_O \div MA/FH_O$				
	÷				
	÷				
EMT/MA_O (4)	$MMH/MA_O \div MEN_O$				
	÷				
	÷				
MMH/FH_I (5)	$MMH/FH_O \times MIIR$				
	X				
	X				
MA/FH_I (6)	$MA/FH_O \times FIIR$				
	X				
	X				
MMH/MA_I (7)	$MMH/FH_I \div MA/FH_I$				
	÷				
	÷				
EMT/MA_I (8)	$MMH/MA_I \div MEN_I$				
	÷				
	÷				
$MMH/FH_{O,I}$ (9)	$MMH/FH_O + MMH/FH_I$				

FIGURE 5.4-3 Worksheet for Evaluating System Maintenance Requirements

5.5 AUXILIARY POWER PLANT SYSTEM - WUC 24

Selected Parameters: Index constants were established for auxiliary power unit.

Number of Regression Equations Run: 0

Parameters Considered and Rejected: 0

Comments: The A-4M, AV-8A and S-3A were the only aircraft with APU's installed. This small sample of aircraft prevented using regression analysis techniques. To achieve a broader APU maintenance base, 18 months of data on the CH-46F, CH-53D and P-3C were added to the A-4M, AV-8A and S-3A data base. Since design parameters were not available on these aircraft, regression analysis techniques could not be considered. Consequently, general mathematical techniques were used in calculating index constants from data presented in Table 5.5-1.

A Maintenance Index of 0.192 MMH/FH was determined by averaging Class 1 O-level MMH/FH. A Frequency Index of 0.37 MA/FH was determined by averaging Class 1 O-level MA/FH. Given these two equations, the remaining Class 1 Baseline parameters can be calculated. Results are shown in Figure 5.5-1.

Using Equation 3.8 of Section 3.0, a Maintenance Index Defect Ratio (MIDR) was found to be 0.36. Similarly, using Equation 3.9, a Frequency Index Defect Ratio (FIDR) was found to be 0.52. Both MIDR and FIDR are used in converting Class 3 contractor predictions to Class 1 predictions.

TABLE 5.5-1 TWO-DIGIT WUC MAINTENANCE DATA SUMMARY

WUC: 24 SYSTEM: Auxiliary Power Unit

ACFT	CLASS 1 MAINTENANCE - 3M										
	O LEVEL					I LEVEL					TOTAL
	MMH/FH	MA/FH	MMH/MA	EMT/MA	MEN	MMH/FH	MA/FH	MMH/MA	EMT/MA	MEN	MMH/FH
A4M	.173	.037	4.70	2.50	1.9	.030	.005	6.50	4.03	1.6	.203
AV8A	.214	.029	7.38	3.58	2.0	.064	.010	6.44	4.95	1.3	.278
S3A	.265	.059	4.49	2.20	2.0	.052	.013	4.00	2.56	1.6	.317
CH46F	.156	.029	5.38	2.68	2.0	.035	.007	5.00	3.40	1.5	.191
CH53D	.166	.038	4.37	2.18	2.0	.037	.009	4.11	2.79	1.5	.203
P3C	.176	.029	6.06	3.02	2.0	.039	.007	5.57	3.79	1.4	.215
	CLASS 3 MAINTENANCE - DESIGN EQUIVALENT										
A4M	.049	.019	2.56	1.41	1.8	.017	.004	4.16	2.74	1.5	.065
AV8A	.087	.015	5.81	2.53	2.3	.030	.005	6.09	4.78	1.3	.118
S3A	.101	.032	3.16	1.46	2.1	.028	.011	2.58	1.73	1.5	.130
CH46F	*										
CH53D	*										
P3C	*										

*Data not available from MSO 4790.A2142-01, Fleet Weapon System Reliability and Maintainability Statistical Summary.

WUC. 24 CONTRACTOR

SYSTEM: Auxiliary Power Unit AIRCRAFT MODEL

PART I CONTRACTOR DATA

CONTRACTOR PREDICTIONS – CLASS 3 DESIGN MAINT. REQ.				
ML	MMH/FH	MA/FH	MMH/MA	EMT/MA
O				
I				

DESIGN/PERFORMANCE PARAMETERS	
APU Factor, 1 or 0	

PART II SYSTEM CONSTANTS

PARAMETER		BASE	PRED
MEN_O	AVG NO. MEN – O LEVEL	2.0	
MEN_I	AVG NO. MEN – I LEVEL	1.5	
MIIR	MMH/FH I LEVEL RATIO	.22	
FIIR	MA/FH I LEVEL RATIO	.23	

PART III SYSTEM ANALYSIS

PARAMETER	CALCULATION	BASELINE CLASS 1 3-M DATA (A)	PREDICTED CLASS 1 3-M DATA (B)	IMPROVEMENT (DEGRADATION) (C) Δ	%
MMH/FH_O (1)	MAINT. INDEX GRAPH				
	BASELINE	.192			
	PREDICTED				
MA/FH_O (2)	FREQ. INDEX GRAPH				
	BASELINE	.037			
	PREDICTED				
MMH/MA_O (3)	MMH/FH_O ÷ MA/FH_O				
	0.192 ÷ 0.037	5.19			
	÷				
EMT/MA_O (4)	MMH/MA_O ÷ MEN_O				
	5.19 ÷ 2.0	2.59			
	÷				
MMH/FH_I (5)	MMH/FH_O X MIIR				
	0.192 X 0.22	.042			
	X				
MA/FH_I (6)	MA/FH_O X FIIR				
	0.037 X 0.23	.009			
	X				
MMH/MA_I (7)	MMH/FH_I ÷ MA/FH_I				
	0.042 ÷ .009	4.67			
	÷				
EMT/MA_I (8)	MMH/MA_I ÷ MEN_I				
	4.67 ÷ 1.5	3.11			
	÷				
$MMH/FH_{O,I}$ (9)	MMH/FH_O + MMH/FH_I	0.234			

FIGURE 5.5-1 Worksheet for Evaluating System Maintenance Requirements

5.6 POWER PLANT INSTALLATION SYSTEM - WUC 29

Selected Parameters: Thrust per engine, uninstalled and number of engines.

Number of Regression Equations Run: 29

Parameters Considered and Rejected: Total engine thrust, empty weight, engine weight and maximum speed.

Comments: This system proved to be very troublesome. It was difficult to achieve satisfactory regression equation correlation using the same aircraft and the same parameters for both MMH/FH and MA/FH. The 18 month data base used in the engine (WUC 23) analysis was used with no improvement or significant difference from the 4 to 12 month baseline data. Excellent correlations could be obtained in the MMH/FH equations with several parameters and only marginal correlations in the MA/FH equations using those same parameters. This was apparently due to a wide spread in MMH/MA.

The F-14A was eliminated because the actual MMH/FH and MA/FH were some three times higher than any of the other aircraft. Power Plant Controls (SWUC 29B) was the primary reason for the F-14A high maintenance. The F-8J was eliminated because of poor regression equation correlation.

TABLE 5.6-1 TWO-DIGIT WUC MAINTENANCE DATA SUMMARY

WUC: 29 SYSTEM: Power Plant Installation

ACFT	O LEVEL					I LEVEL					TOTAL
	MMH/FH	MA/FH	MMH/MA	EMT/MA	MEN	MMH/FH	MA/FH	MMH/MA	EMT/MA	MEN	MMH/FH
CLASS 1 MAINTENANCE - 3M											
A4M	.084	.018	4.82	2.72	1.8	.006	.005	1.50	1.50	1.0	.090
A6E	.169	.027	6.27	3.06	2.0	.035	.008	4.19	3.18	1.3	.204
A7E	.117	.028	4.15	2.06	2.0	.011	.005	2.43	2.23	1.1	.128
AV8A	.211	.051	4.13	2.27	1.8	.060	.008	7.50	5.00	1.5	.271
F4J	.244	.033	7.33	3.46	2.1	.020	.005	3.71	2.96	1.2	.264
F8J	.229	.067	3.41	1.94	1.7	.070	.015	4.62	3.37	1.4	.299
F14A	1.025	.182	5.66	2.64	2.1	.330	.041	8.08	5.51	1.5	1.355
S3A	.244	.055	4.08	2.18	1.9	.022	.008	2.75	1.91	1.4	.246
CLASS 3 MAINTENANCE - DESIGN EQUIVALENT											
A4M	.034	.012	2.80	1.62	1.7	.005	.004	1.30	1.05	1.2	.039
A6E	.082	.019	4.31	1.95	2.2	.021	.007	3.03	2.34	1.3	.103
A7E	.061	.022	2.76	1.31	2.1	.008	.004	1.88	1.67	1.1	.068
AV8A	.109	.034	3.19	1.64	1.9	.038	.008	4.73	3.79	1.2	.146
F4J	.127	.025	5.06	2.21	2.3	.011	.004	2.66	2.08	1.3	.137
F8J	.122	.055	2.22	1.23	1.8	.040	.012	3.35	2.49	1.3	.162
F14A	.197	.098	5.49	2.01	2.7	.184	.032	5.75	4.14	1.4	.381
S3A	.095	.032	2.97	1.50	2.0	.017	.008	2.14	1.39	1.5	.112

TABLE 5.6-2 REGRESSION ANALYSIS SUMMARY

WUC: 29 SYSTEM: POWER PLANT INSTALLATION

MAINTENANCE INDEX ESTIMATION - MMH/FH O LEVEL

ACFT	3M MI		ERROR	THRUST PER ENGINE UNINST. X 10^3 LBS (THRUST)	NUMBER OF ENGINES (ENGQTY)
	ACTUAL	CALCULATED			
A4M	.084	.089	-.005	11.2	1
A6E	.169	.195	-.026	9.3	2
A7E	.117	.112	.005	15.0	1
F4J	.244	.246	-.002	17.9	2
S3A	.224	.195	.029	9.275	2

STATISTICAL PARAMETERS:

REGRESSION EQUATION	MI =	-0.0943 + 0.0059 (THRUST) +0.1174(ENGQTY)
CORRELATION COEFFICIENT	r =	0.9564
STANDARD ERROR OF ESTIMATE	S =	0.0281
CONFIDENCE LEVEL, 95%	2S =	±0.0562
NUMBER OF OBSERVATIONS	N =	5

FREQUENCY INDEX ESTIMATION - MA/FH O LEVEL

ACFT	3M FI		ERROR	THRUST PER ENGINE UNINST. X 10^3 LBS (THRUST)	NUMBER OF ENGINES (ENGQTY)
	ACTUAL	CALCULATED			
A4M	.017	.021	-.005	11.2	1
A6E	.027	.020	.007	9.3	2
A7E	.028	.030	-.002	15.0	1
AV8A	.051	.044	.007	20.9	1
F4J	.033	.040	-.007	17.9	2

STATISTICAL PARAMETERS:

REGRESSION EQUATION	FI =	-0.0069 + 0.0023 (THRUST) +0.0028 (ENGQTY)
CORRELATION COEFFICIENT	r =	0.8514
STANDARD ERROR OF ESTIMATE	S =	0.0093
CONFIDENCE LEVEL, 95%	2S =	±0.0186
NUMBER OF OBSERVATIONS	N =	5

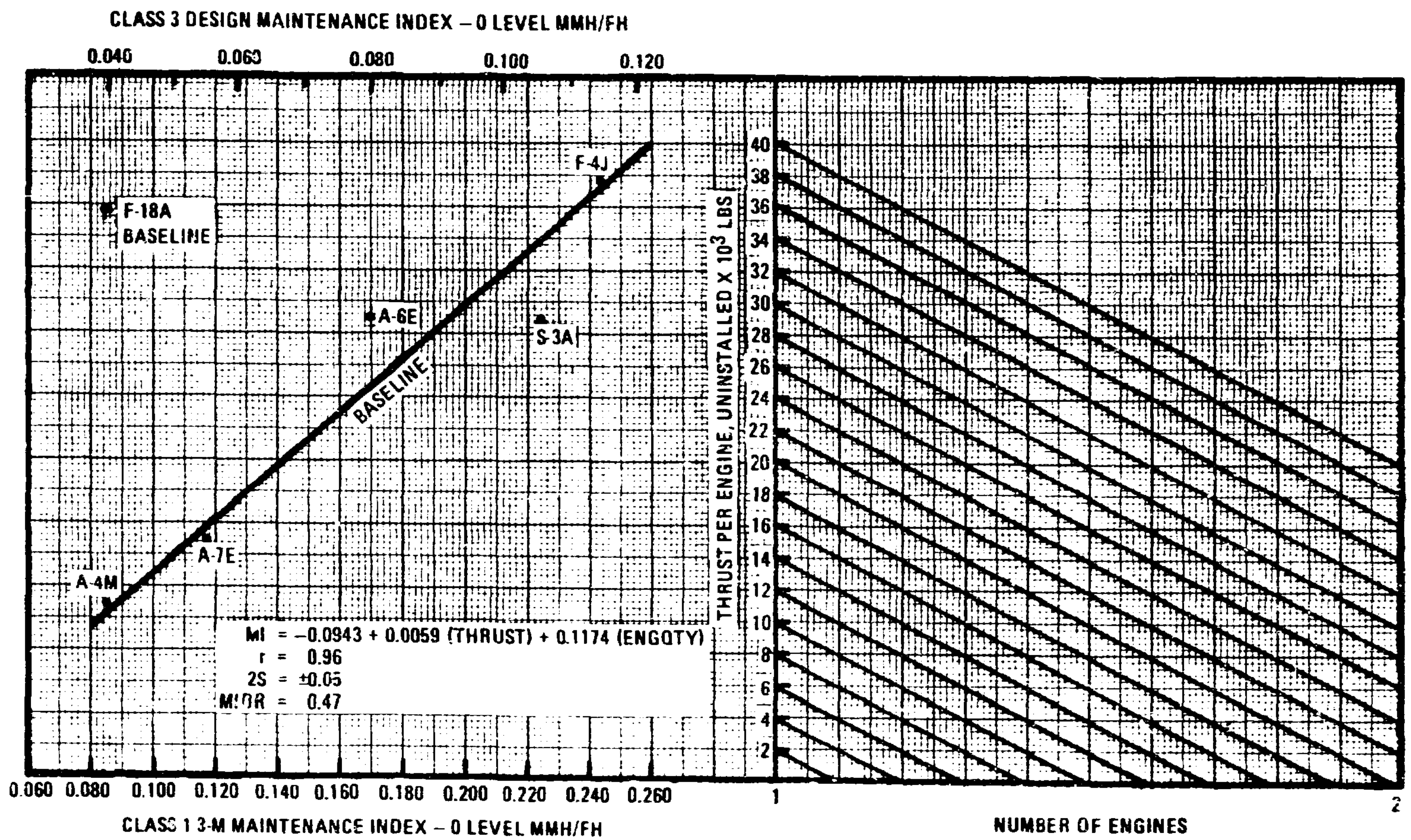


Figure 5.6-1 WUC 29 Maintenance Index Graph

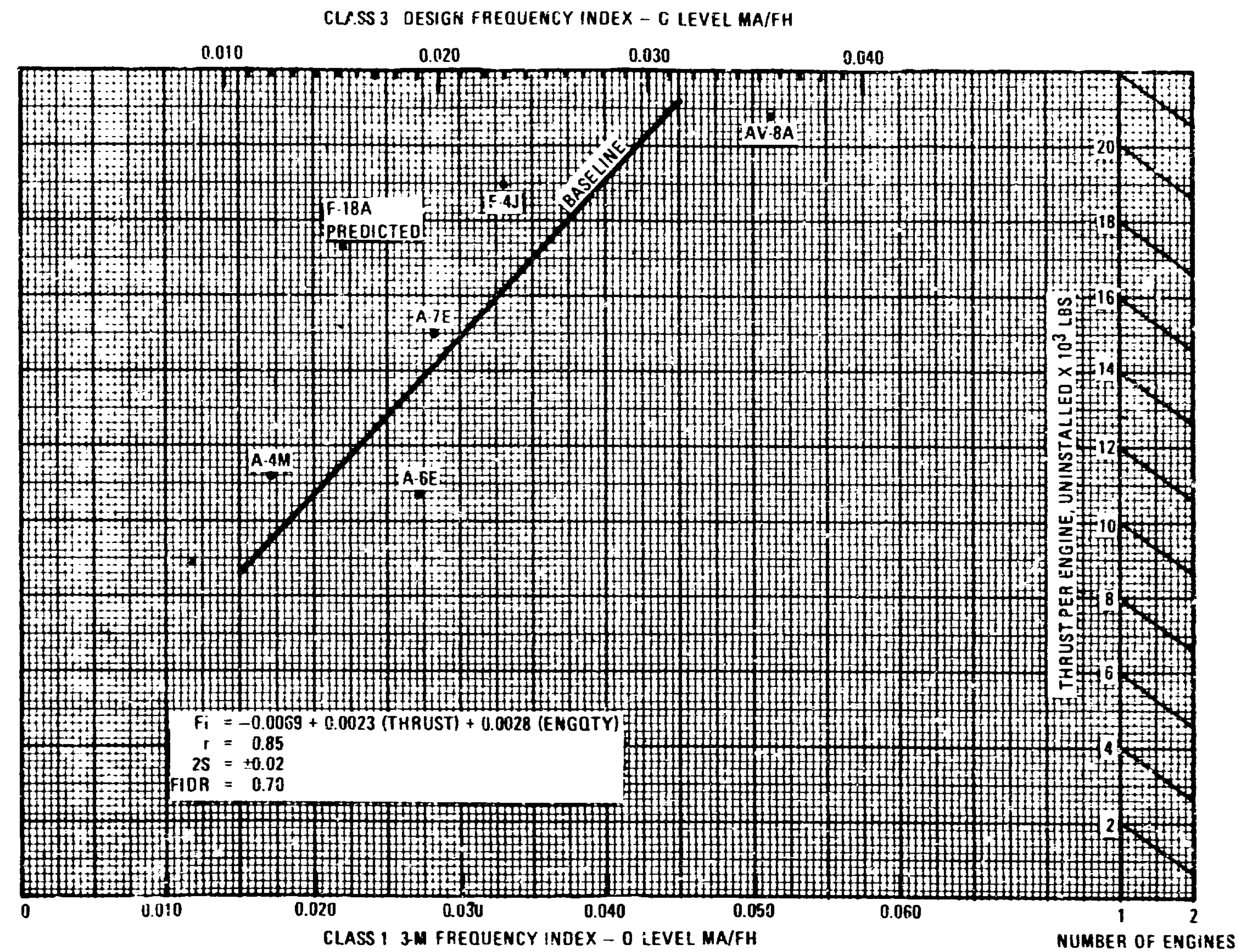


Figure 5.6-2 WUC 29 Frequency Index Graph

WUC: 29 CONTRACTOR ____________

SYSTEM: Power Plant Installation AIRCRAFT MODEL ____________

PART I CONTRACTOR DATA

CONTRACTOR PREDICTIONS – CLASS 3 DESIGN MAINT. REQ.				
ML	MMH/FH	MA/FH	MMH/MA	EMT/MA
O				
I				

DESIGN/PERFORMANCE PARAMETERS	
Thrust per engine, Uninstalled lbs Number of engines	

PART II SYSTEM CONSTANTS

PARAMETER		BASE	PRED
MEN_O	AVG NO. MEN O LEVEL	2.0	
MEN_I	AVG NO MEN I LEVEL	1.2	
MIIR	MMH/FH I LEVEL RATIO	.11	
FIIR	MA/FH I LEVEL RATIO	.21	

PART III SYSTEM ANALYSIS

PARAMETER	CALCULATION	BASELINE CLASS 1 3-M DATA (A)	PREDICTED CLASS 1 3-M DATA (B)	IMPROVEMENT (DEGRADATION) (C) Δ	%
MMH/FH_O (1)	MAINT. INDEX GRAPH				
	BASELINE				
	PREDICTED				
MA/FH_O (2)	FREQ. INDEX GRAPH				
	BASELINE				
	PREDICTED				
MMH/MA_O (3)	$MMH/FH_O \div MA/FH_O$				
	÷				
EMT/MA_O (4)	MMH/MA_O MEN_O				
	÷				
MMH/FH_I (5)	$MMH/FH_O \times MIIR$				
	×				
	×				
MA/FH_I (6)	$MA/FH_O \times FIIR$				
	×				
	×				
MMH/MA_I (7)	$MMH/FH_I \div MA/FH_I$				
	÷				
	÷				
EMT/MA_I (8)	$MMH/MA_I \div MEN_I$				
	÷				
	÷				
$MMH/FH_{O,I}$ (9)	$MMH/FH_O + MMH/FH_I$				

FIGURE 5.6-3 Worksheet for Evaluating System Maintenance Requirements

5.7 AIR CONDITIONING SYSTEM - WUC 41

Selected Parameters: Empty weight and avionics weight installed. Index constants were established for boundary layer control.

Number of Regression Equations Run: 15

Parameters Considered and Rejected: Fuselage volume pressurized, ECS weight, maximum takeoff weight and KVA.

Comments: Empty weight and installed avionics weight were the two design parameters selected as having the greatest impact on Air Conditioning maintenance. Those aircraft with large quantities of avionics equipment required more avionics cooling thus increasing the maintenance burden for this system. Such parameters as ECS weight, KVA output and pressurized fuselage volume were rejected by the regression analysis program. Intuitively, one would expect these parameters to impact Air Conditioning System maintenance. Analysis showed this not to be the case.

Boundary layer control was excluded from the F-8J and F-4J MMH/FH and MA/FH totals for the regression equations. Index constants were established for aircraft with boundary layer control. These constants should be added to the regression equation totals. Data used to establish the index constants is as follows:

	AIRCRAFT	MMH/FH	MA/FH
	F-4J	0.213	0.014
	F-8J	0.118	0.019
Total		0.331	0.033

BLC MMH/FH Index Constant $0.331 \div 2 = 0.166$
BLC MA/FH Index Constant $0.033 \div 2 = 0.016$

TABLE 5.7-1 TWO-DIGIT WUC MAINTENANCE DATA SUMMARY

WUC: 41 SYSTEM: Air Conditioning

ACFT	CLASS 1 MAINTENANCE - 3M										
	O LEVEL					I LEVEL					TOTAL
	MMH/FH	MA/FH	MMH/MA	EMT/MA	MEN	MMH/FH	MA/FH	MMH/MA	EMT/MA	MEN	MMH/FH
A4M	.051	.019	2.67	1.82	1.5	.007	.002	2.96	2.39	1.2	.058
A6E	.205	.048	4.27	2.55	1.7	.017	.010	1.71	1.48	1.1	.222
A7E	.146	.032	4.61	2.79	1.6	.028	.011	2.68	2.44	1.1	.173
AV8A	.128	.023	5.64	3.44	1.6	.016	.005	3.20	2.00	1.6	.144
F4J	.499	.062	8.08	4.38	1.8	.016	.011	1.43	1.19	1.2	.515
F8J	.296	.062	4.77	2.92	1.6	.023	.019	1.21	1.10	1.1	.319
F14A	.500	.081	6.17	3.07	2.0	.047	.014	3.35	2.38	1.4	.547
S3A	.383	.072	5.32	2.86	1.9	.053	.013	4.07	2.69	1.5	.436
	CLASS 3 MAINTENANCE - DESIGN EQUIVALENT										
A4M	.021	.012	1.78	1.18	1.5	.004	.002	1.99	1.65	1.2	.025
A6E	.102	.030	3.40	1.71	2.0	.012	.009	1.33	1.09	1.2	.114
A7E	.069	.023	2.99	1.67	1.8	.018	.009	1.98	1.76	1.1	.087
AV8A	.057	.014	4.05	2.17	1.9	.011	.005	2.29	1.63	1.4	.068
F4J	.256	.045	5.68	2.85	2.0	.011	.010	1.12	.90	1.2	.267
F8J	.152	.045	3.37	1.86	1.8	.019	.017	1.10	.80	1.4	.171
F14A	.224	.054	4.16	1.95	2.1	.030	.013	2.29	1.63	1.4	.254
S3A	.125	.025	5.02	2.33	2.1	.012	.008	1.46	.93	1.6	.137

TABLE 5.7-2 REGRESSION ANALYSIS SUMMARY

WUC: 41 SYSTEM: Air Conditioning

MAINTENANCE INDEX ESTIMATION - MMH/FH O LEVEL

ACFT	3M MI		ERROR	WEIGHT EMPTY X 10^3 LBS (WTMT)	WEIGHT AVIONICS INSTALLED X 10^3 LBS (WTAVIN)
	ACTUAL	CALCULATED			
A4M	.051	.058	-.007	10.4	.612
A6E	.205	.281	-.076	26.0	2.329
A7E	.146	.172	-.026	18.9	1.347
AV8A	.128	.073	.054	12.0	.590
F4J	.286	.342	-.056	30.8	2.641
F8J	.178 *	.162	.016	19.8	.819
F14A	.500 *	.432	.068	38.2	3.039
S3A	.383	.356	.027	26.6	4.223

STATISTICAL PARAMETERS:

REGRESSION EQUATION	MI =	-0.0717 + 0.0103 (WTMT) +0.0364 (WTAVIN)
CORRELATION COEFFICIENT	r =	0.9385
STANDARD ERROR OF ESTIMATE	S =	0.0602
CONFIDENCE LEVEL, 95%	2S =	±0.1204
NUMBER OF OBSERVATIONS	N =	8

FREQUENCY INDEX ESTIMATION - MA/FH O LEVEL

ACFT	3M FI		ERROR	WEIGHT EMPTY X 10^3 LBS (WTMT)	WEIGHT AVIONICS INSTALLED X 10^3 LBS (WTAVIN)
	ACTUAL	CALCULATED			
A4M	.019	.020	-.001	10.4	.612
A6E	.048	.052	-.004	26.0	2.329
A7E	.032	.036	-.004	18.9	1.347
AV8A	.023	.022	.001	12.0	.590
F4J	.048	.061	-.013	30.8	2.641
F8J	.043 *	.034	.009	19.8	.819
F14A	.081 *	.074	.007	38.2	3.039
S3A	.072	.067	.005	26.6	4.223

STATISTICAL PARAMETERS:

REGRESSION EQUATION	FI =	0.0019 + 0.0013 (WTMT) +0.0072 (WTAVIN)
CORRELATION COEFFICIENT	r =	0.9419
STANDARD ERROR OF ESTIMATE	S =	0.0087
CONFIDENCE LEVEL, 95%	2S =	±0.0174
NUMBER OF OBSERVATIONS	N =	8

* BLC Data Excluded

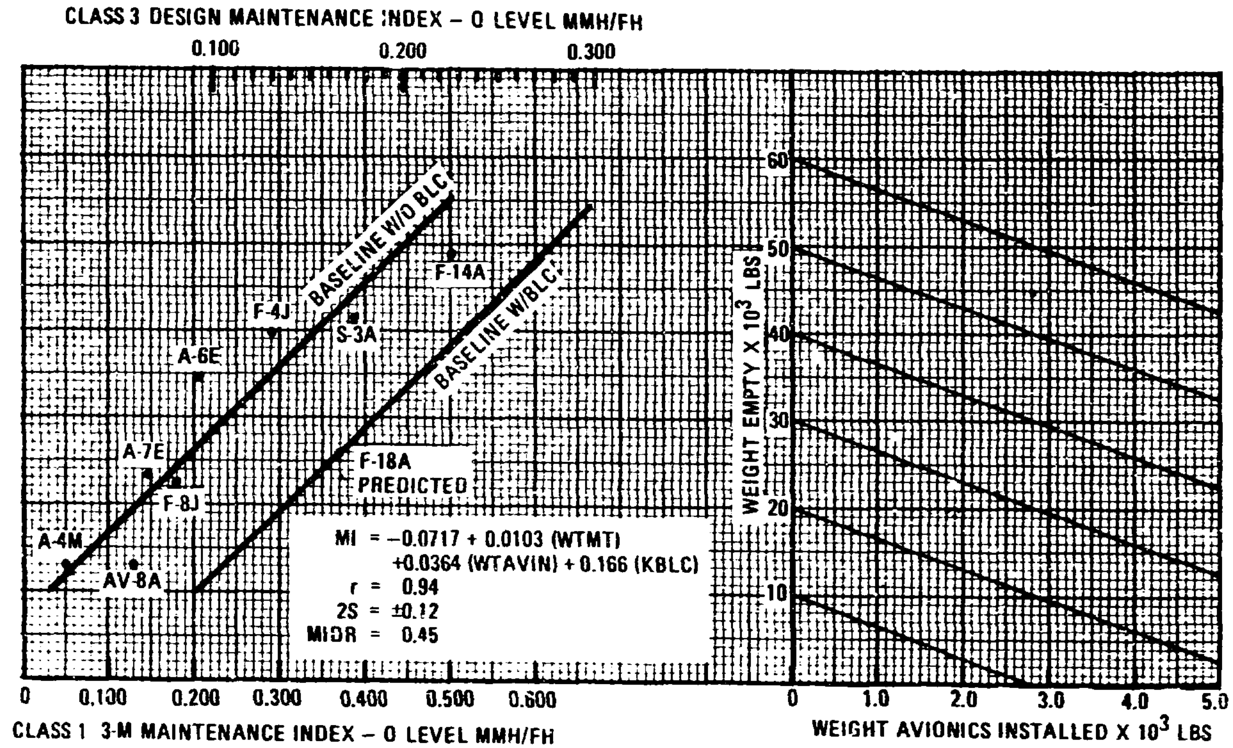


Figure 5.7-1 WUC 41 Maintenance Index Graph

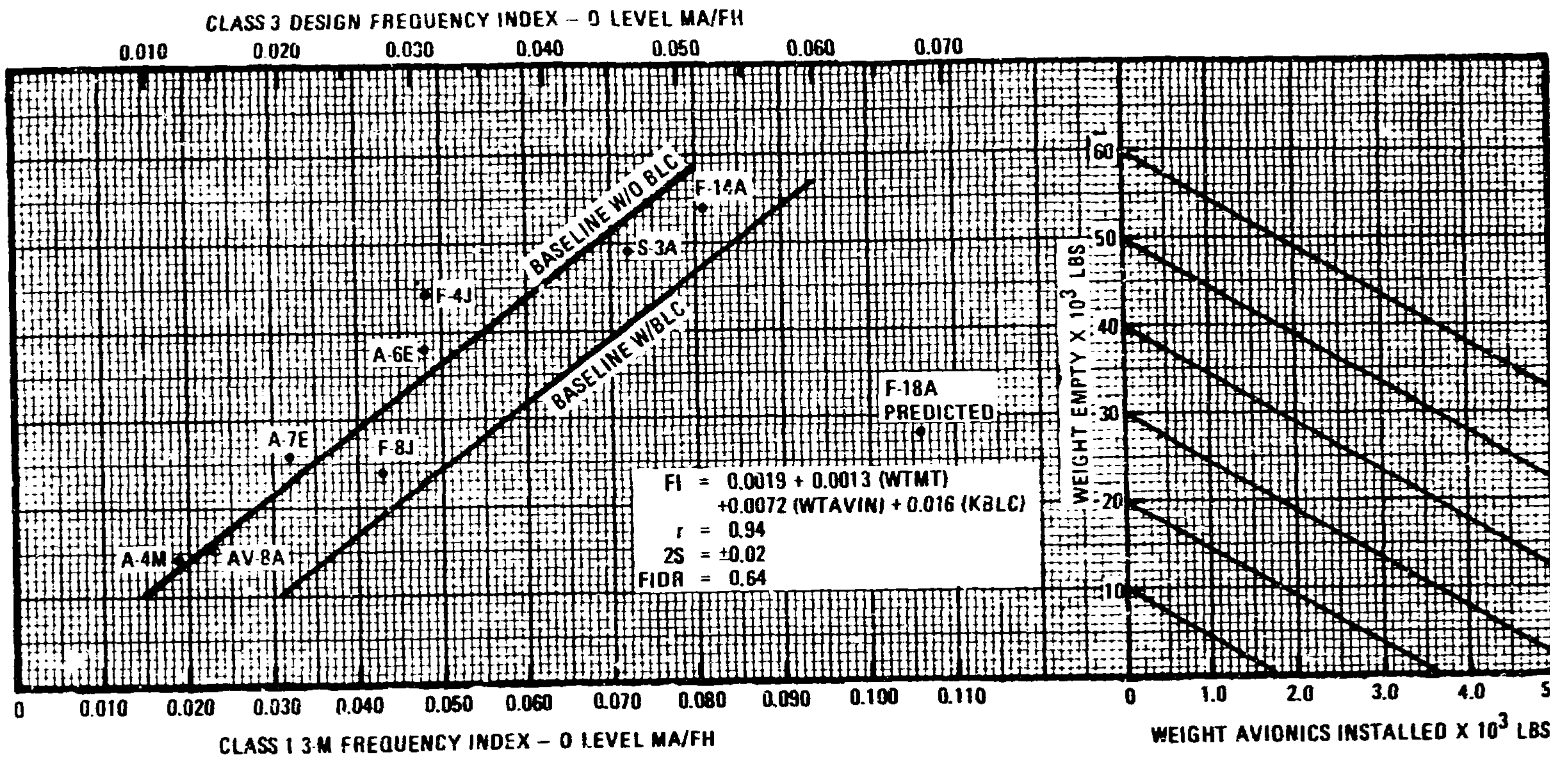


Figure 5.7-2 WUC 41 Frequency Index Graph

WUC. 41 CONTRACTOR: ______

SYSTEM: Air Conditioning AIRCRAFT MODEL. ______

PART I CONTRACTOR DATA

CONTRACTOR PREDICTIONS – CLASS 3 DESIGN MAINT. REQ.				
ML	MMH/FH	MA/FH	MMH/MA	EMT/MA
O				
I				

DESIGN/PERFORMANCE PARAMETERS	
Weight Empty, lbs. Weight Avionics Installed, lbs. BLC Factor, 1 or 0	

PART II SYSTEM CONSTANTS

PARAMETER		BASE	PRED
MEN_O	AVG NO. MEN O LEVEL	1.7	
MEN_I	AVG NO. MEN - I LEVEL	1.3	
MIIR	MMH/FH I LEVEL RATIO	.11	
FIIR	MA/FH I LEVEL RATIO	.21	

PART III SYSTEM ANALYSIS

PARAMETER	CALCULATION	BASELINE CLASS 1 3-M DATA (A)	PREDICTED CLASS 1 3-M DATA (B)	IMPROVEMENT (DEGRADATION) (C) Δ	%
MMH/FH_O (1)	MAINT. INDEX GRAPH				
	BASELINE				
	PREDICTED				
MA/FH_O (2)	FREQ INDEX GRAPH				
	BASELINE				
	PREDICTED				
MMH/MA_O (3)	$MMH/FH_O \div MA/FH_O$				
	÷				
	÷				
EMT/MA_O (4)	$MMH/MA_O \div MEN_O$				
	÷				
	÷				
MMH/FH_I (5)	MMH/FH_O X MIIR				
	X				
	X				
MA/FH_I (6)	MA/FH_O X FIIR				
	X				
	X				
MMH/MA_I (7)	$MMH/FH_I \div MA/FH_I$				
	÷				
	÷				
EMT/MA_I (8)	$MMH/MA_I \div MEN_I$				
	÷				
	÷				
$MMH/FH_{O,I}$ (9)	$MMH/FH_O + MMH/FH_I$				

FIGURE 5.7-3 Worksheet for Evaluating System Maintenance Requirements

5.8 ELECTRICAL SYSTEM - WUC 42

Selected Parameters: Empty weight and KVA.

Number of Regression Equations Run: 24

Parameters Considered and Rejected: Avionics weight installed and fuselage length.

Comments: The A-4M was eliminated due to poor regression correlation. Actual MMH/FH ran three times higher than it should have for its given weight and power requirements. The reason for this was not identified.

The AV-8A was not used because of very high DC power maintenance. Actual system maintenance exceeded its calculated MMH/FH value by a factor of four and its calculated MA/FH value by a factor of nine. DC power maintenance on other aircraft was negligible.

The A-6E and F-8J were also excluded from the regression analysis because of poor correlation caused by excessively high wiring maintenance. Both aircraft exhibited from two to three times higher wiring maintenance than the other aircraft.

On the average, aircraft wiring problems account for almost half of the Electrical System maintenance.

TABLE 5.8-1 TWO-DIGIT WUC MAINTENANCE DATA SUMMARY

WUC: 42 SYSTEM: Electrical

ACFT	CLASS 1 MAINTENANCE - 3M										
	O LEVEL					I LEVEL					TOTAL
	MMH/FH	MA/FH	MMH/MA	EMT/MA	MEN	MMH/FH	MA/FH	MMH/MA	EMT/MA	MEN	MMH/FH
A4M	.339	.072	4.72	2.58	1.8	.028	.009	3.18	2.31	1.4	.367
A6E	.890	.179	4.97	2.75	1.8	.277	.033	8.29	5.49	1.5	1.167
A7E	.332	.046	7.25	3.55	2.0	.042	.010	4.01	3.38	1.2	.374
AV8A	.596	.208	2.85	1.63	1.7	.400	.047	8.42	5.24	1.6	.996
F4J	.636	.075	8.51	4.36	1.9	.128	.020	6.48	4.16	1.5	.764
F8J	1.001	.123	8.10	4.29	1.9	.075	.019	3.98	2.63	1.5	1.076
F14A	.785	.108	7.20	3.20	2.2	.125	.018	6.75	4.14	1.6	.910
S3A	.477	.075	6.39	3.24	2.0	.047	.018	2.57	1.98	1.3	.524
	CLASS 3 MAINTENANCE - DESIGN EQUIVALENT										
A4M	.145	.045	3.22	1.69	1.9	.019	.008	2.31	1.71	1.3	.164
A6E	.380	.113	3.36	1.79	1.9	.121	.023	5.27	3.09	1.7	.501
A7E	.160	.035	4.58	2.10	2.2	.025	.008	3.10	2.65	1.1	.185
AV8A	.265	.182	1.45	.96	1.5	.173	.039	4.45	3.13	1.4	.438
F4J	.293	.052	5.63	2.66	2.1	.065	.014	4.68	3.20	1.5	.358
F8J	.515	.099	5.20	2.52	2.0	.039	.014	2.81	1.99	1.4	.554
F14A	.353	.069	5.11	2.11	2.4	.058	.012	4.83	3.21	1.5	.411
S3A	.205	.047	4.36	2.07	2.1	.030	.016	1.89	1.45	1.3	.235

TABLE 5.8-2 REGRESSION ANALYSIS SUMMARY

WUC: 42 SYSTEM: Electrical

MAINTENANCE INDEX ESTIMATION - MMH/FH O LEVEL

ACFT	3M MI		ERROR	WEIGHT EMPTY X 10^3 LBS (WTMT)	GENERATOR ELECT. POWER X 10^2 KVA (GENKVA)
	ACTUAL	CALCULATED			
A-7E	.332	.336	-.004	18.9	.25
F4J	.635	.628	.007	30.8	.60
F14A	.785	.790	-.005	38.2	1.20
S3A	.477	.475	.002	26.6	1.50

STATISTICAL PARAMETERS:

REGRESSION EQUATION	MI =	-0.1419 + 0.0259 (WTMT) -0.0485 (GENKVA)
CORRELATION COEFFICIENT	r =	0.9995
STANDARD ERROR OF ESTIMATE	S =	0.0102
CONFIDENCE LEVEL, 95%	2S =	±0.0204
NUMBER OF OBSERVATIONS	N =	4

FREQUENCY INDEX ESTIMATION - MA/FH O LEVEL

ACFT	3M FI		ERROR	WEIGHT EMPTY X 10^3 LBS (WTMT)	GENERATOR ELECT. POWER X 10^2 KVA (GENKVA)
	ACTUAL	CALCULATED			
A7E	.046	.044	.002	18.9	.25
F4J	.075	.079	-.004	30.8	.60
F14A	.108	.105	.003	38.2	1.20
S3A	.075	.076	-.001	26.6	1.50

STATISTICAL PARAMETERS:

REGRESSION EQUATION	FI =	-0.0100 + 0.0027 (WTMT) +0.0092 (GENKVA)
CORRELATION COEFFICIENT	r =	0.9910
STANDARD ERROR OF ESTIMATE	S =	0.0058
CONFIDENCE LEVEL, 95%	2S =	±0.0116
NUMBER OF OBSERVATIONS	N =	4

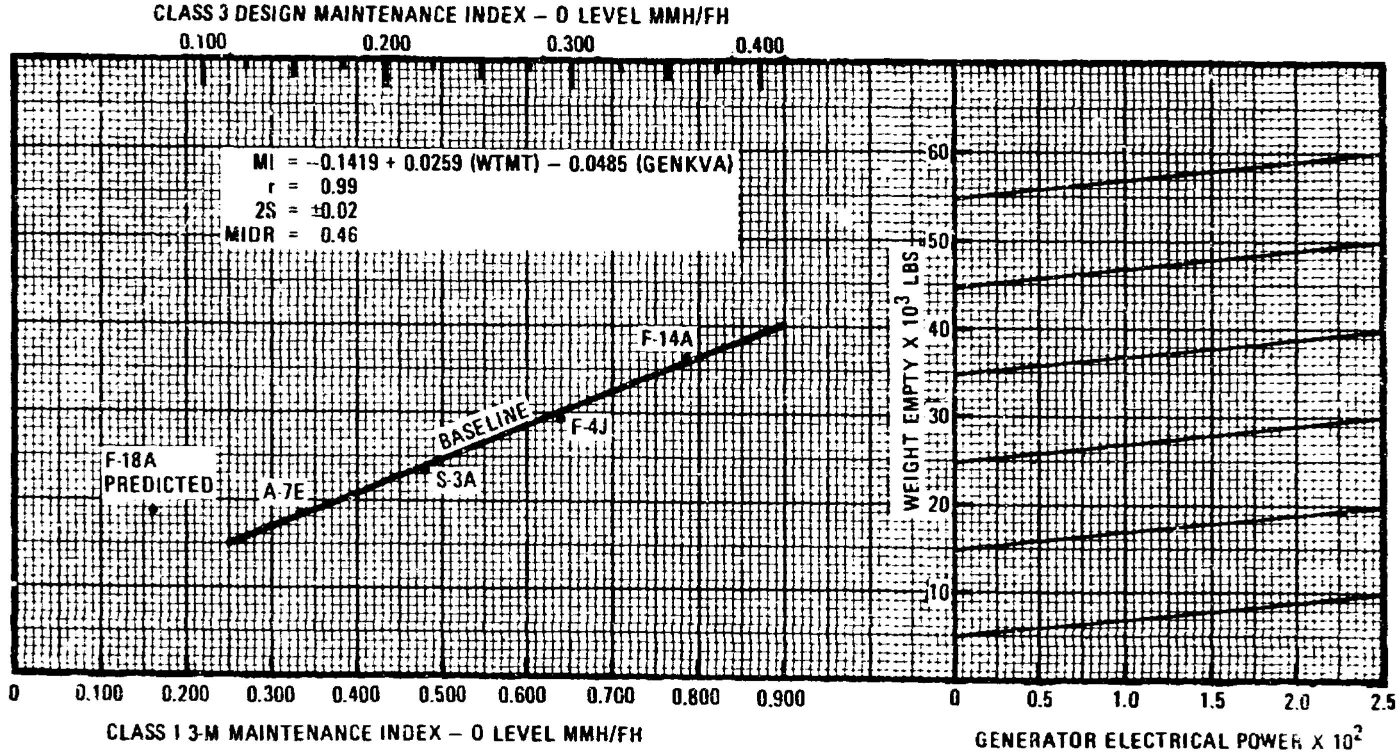


Figure 5.8-1 WUC 42 Maintenance Index Graph

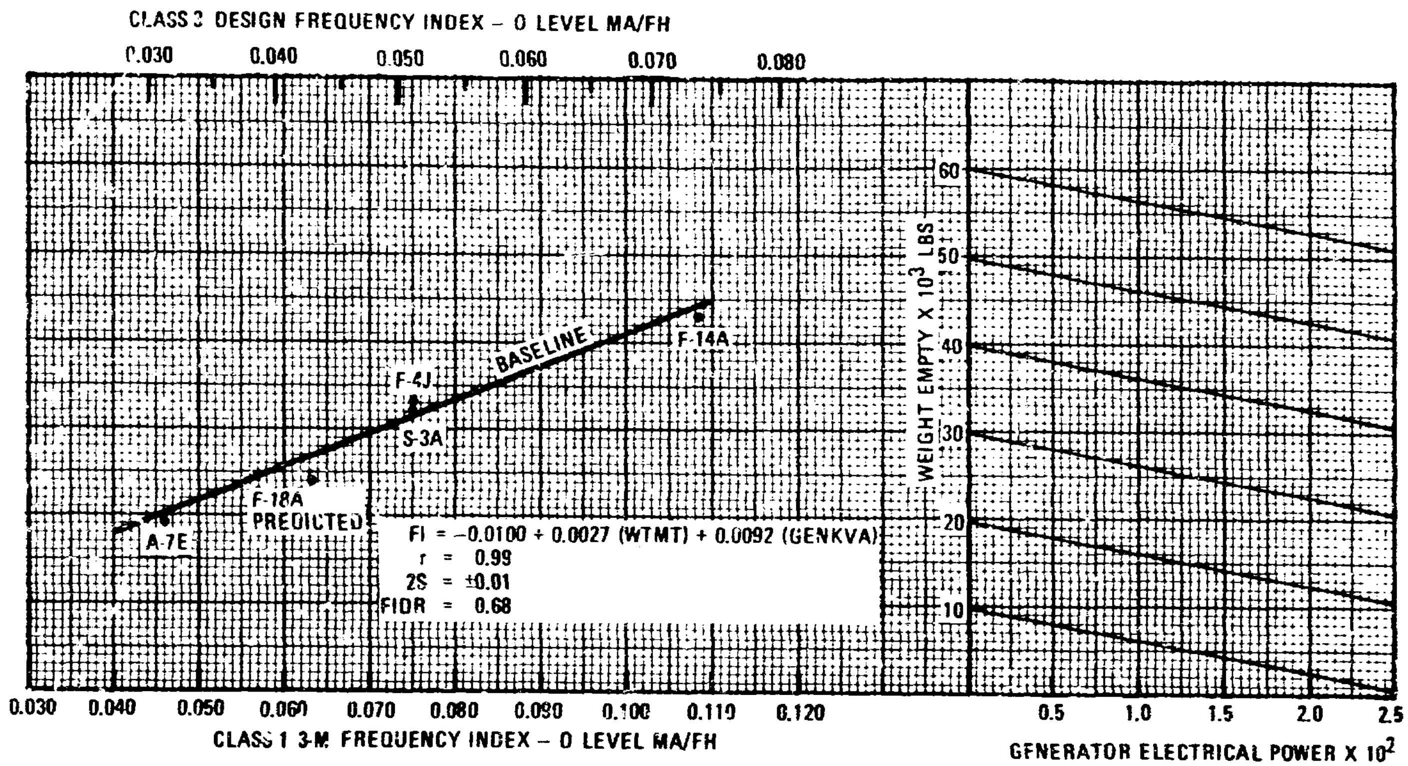


Figure 5.8-2 WUC 42 Frequency Index Graph

WUC 42
SYSTEM Electrical

CONTRACTOR ______________
AIRCRAFT MODEL ______________

PART I CONTRACTOR DATA

CONTRACTOR PREDICTIONS – CLASS 3 DESIGN MAINT. REQ.				
ML	MMH/FH	MA/FH	MMH/MA	EMT/MA
O				
I				

DESIGN/PERFORMANCE PARAMETERS	
Weight Empty, lbs. Generator Electrical Power, KVA	

PART II SYSTEM CONSTANTS

PARAMETER		BASE	PRED
MEN_O	AVG NO. MEN – O LEVEL	2.0	
MEN_I	AVG NO. MEN – I LEVEL	1.4	
MIIR	MMH/FH I LEVEL RATIO	.15	
FIIR	MA/FH I LEVEL RATIO	.22	

PART III SYSTEM ANALYSIS

PARAMETER	CALCULATION	BASELINE CLASS 1 3-M DATA (A)	PREDICTED CLASS 1 3-M DATA (B)	IMPROVEMENT (DEGRADATION) (C)	
				Δ	%
MMH/FH_O (1)	MAINT. INDEX GRAPH				
	BASELINE				
	PREDICTED				
MA/FH_O (2)	FREQ. INDEX GRAPH				
	BASELINE				
	PREDICTED				
MMH/MA_O (3)	$MMH/FH_O \div MA/FH_O$				
EMT/MA_O (4)	$MMH/MA_O \div MEN_O$				
	÷				
	÷				
MMH/FH_I (5)	MMH/FH_O X MIIR				
	X				
	X				
MA/FH_I (6)	MA/FH_O X FIIR				
	X				
	X				
MMH/MA_I (7)	$MMH/FH_I \div MA/FH_I$				
	÷				
	÷				
EMT/MA_I (8)	$MMH/MA_I \div MEN_I$				
$MMH/FH_{O,I}$ (9)	$MMH/FH_O + MMH/FH_I$				

FIGURE 5.8-3 Worksheet for Evaluating System Maintenance Requirements

5.9 LIGHTING SYSTEM - WUC 44

Selected Parameters: Wing area and fuselage length.

Number of Regression Equations Run: 12

Parameters Considered and Rejected: Weight avionics installed and KVA.

Comments: Wing area and fuselage length were the two design parameters selected by the regression analysis program as having the greatest effect on Lighting System maintenance. Aircraft with larger fuselages and greater wing areas inherently require more lighting components resulting in higher system maintenance.

TABLE 5.9-1 TWO-DIGIT WUC MAINTENANCE DATA SUMMARY

WUC: 44 SYSTEM: Lighting

ACFT	CLASS 1 MAINTENANCE - 3M										
	O LEVEL					I LEVEL					TOTAL
	MMH/FH	MA/FH	MMH/MA	EMT/MA	MEN	MMH/FH	MA/FH	MMH/MA	EMT/MA	MEN	MMH/FH
A4M	.122	.065	1.86	1.13	1.6	.078	.016	4.85	3.49	1.4	.200
A6E	.130	.072	1.79	1.23	1.5	.032	.006	4.97	4.51	1.1	.162
A7E	.113	.054	2.07	1.33	1.6	.031	.007	4.59	4.20	1.1	.144
AV8A	.074	.041	1.79	1.31	1.4	.020	.006	3.35	2.42	1.4	.094
F4J	.251	.105	2.39	1.47	1.6	.008	.002	4.69	3.83	1.2	.259
F8J	.171	.093	1.83	1.33	1.4	.044	.008	5.15	3.61	1.4	.215
F14A	.279	.103	2.70	1.40	1.9	.035	.003	11.78	7.89	1.5	.314
S3A	.191	.069	2.76	1.64	1.7	.027	.011	2.30	1.96	1.2	.218
	CLASS 3 MAINTENANCE - DESIGN EQUIVALENT										
A4M	.074	.056	1.33	.82	1.6	.053	.015	3.50	2.57	1.4	.127
A6E	.075	.059	1.27	.86	1.5	.018	.005	3.52	3.20	1.1	.093
A7E	.063	.045	1.39	.89	1.6	.021	.006	3.45	3.17	1.1	.083
AV8A	.043	.033	1.30	.94	1.4	.011	.004	2.78	1.97	1.4	.054
F4J	.143	.087	1.65	.99	1.7	.004	.001	3.74	3.20	1.2	.147
F8J	.103	.079	1.30	.93	1.4	.028	.007	3.96	2.82	1.4	.131
F14A	.155	.090	1.73	.93	1.9	.017	.002	8.52	5.94	1.4	.172
S3A	.099	.053	1.87	1.09	1.7	.018	.010	1.76	1.45	1.2	.115

TABLE 5.9-2 REGRESSION ANALYSIS SUMMARY

WUC: 44 SYSTEM: Lighting

MAINTENANCE INDEX ESTIMATION - MMH/FH O LEVEL

ACFT	3M MI		ERROR	WING AREA X 10^3 FT^2 (WAREA)	FUSELAGE LENGTH X 10^2 FT (FUSLEN)
	ACTUAL	CALCULATED			
A4M	.122	.080	.042	.260	.4130
A7E	.113	.130	-.017	.375	.4610
AV8A	.074	.097	-.023	.201	.4555
F4J	.251	.233	.018	.530	.5810
F8J	.171	.184	-.013	.375	.5450
F14A	.279	.263	.016	.565	.6190
S3A	.191	.213	-.022	.598	.5330

STATISTICAL PARAMETERS:

REGRESSION EQUATION	MI =	-0.2304 + 0.1652 (WAREA) +0.6472 (FUSLEN)
CORRELATION COEFFICIENT	r =	0.9410
STANDARD ERROR OF ESTIMATE	S =	0.0310
CONFIDENCE LEVEL, 95%	2S =	±0.0620
NUMBER OF OBSERVATIONS	N =	7

FREQUENCY INDEX ESTIMATION - MA/FH O LEVEL

ACFT	3M FI		ERROR	WING AREA X 10^3 FT^2 (WAREA)	FUSELAGE LENGTH X 10^2 FT (FUSLEN)
	ACTUAL	CALCULATED			
A6E	.072	.080	-.008	.529	.5475
A7E	.054	.047	.007	.375	.4610
AV8A	.041	.050	-.009	.201	.4555
F4J	.105	.095	.010	.530	.5810
F8J	.093	.084	.009	.375	.5450
F14A	.103	.110	-.007	.565	.6190
S3A	.069	.072	-.003	.598	.5330

STATISTICAL PARAMETERS:

REGRESSION EQUATION	FI =	-0.1458 - 0.0333 (WAREA) +0.4444(FUSLEN)
CORRELATION COEFFICIENT	r =	0.9366
STANDARD ERROR OF ESTIMATE	S =	0.0105
CONFIDENCE LEVEL, 95%	2S =	±0.0210
NUMBER OF OBSERVATIONS	N =	7

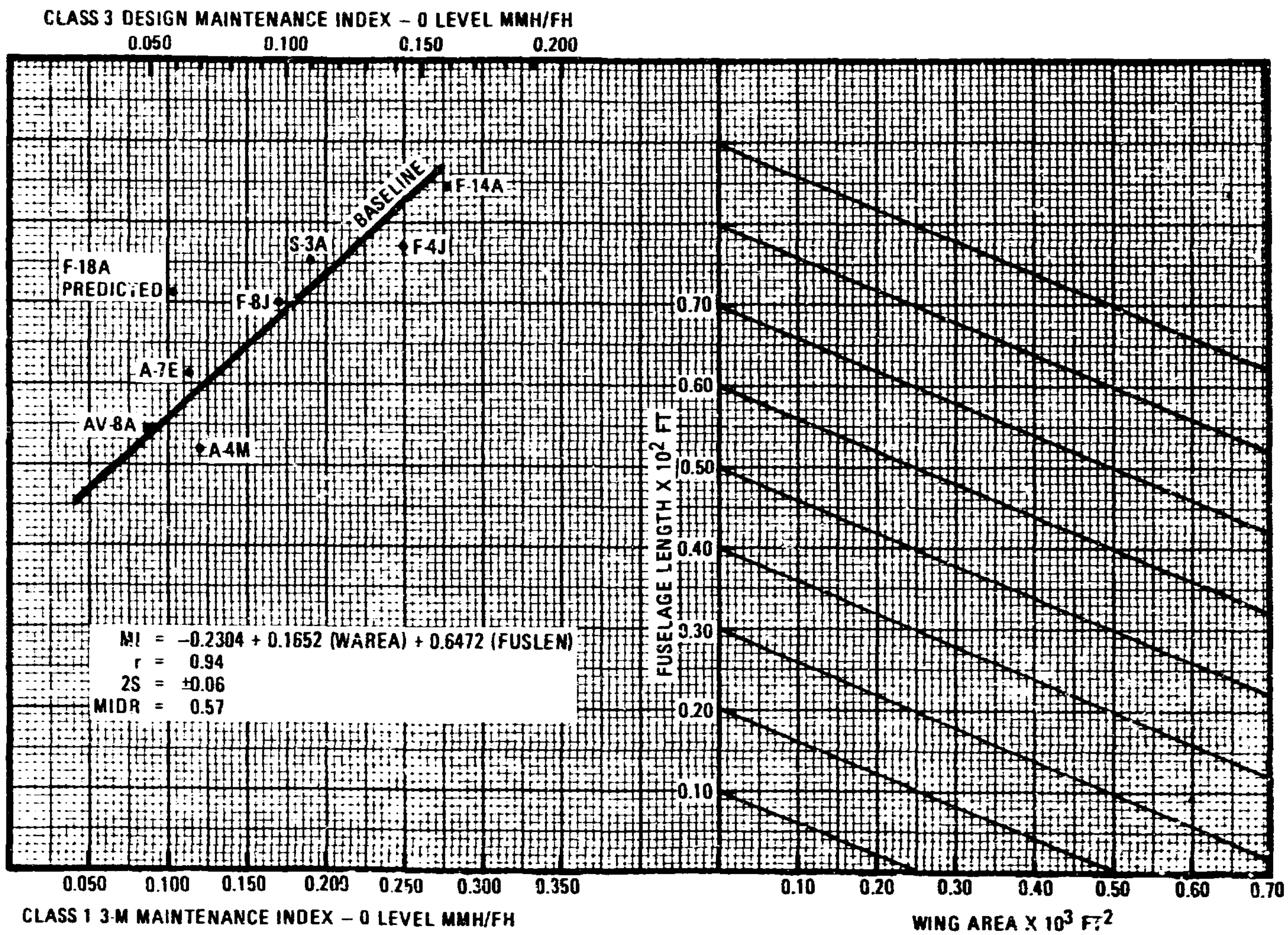


Figure 5.9-1 WUC 44 Maintenance Index Graph

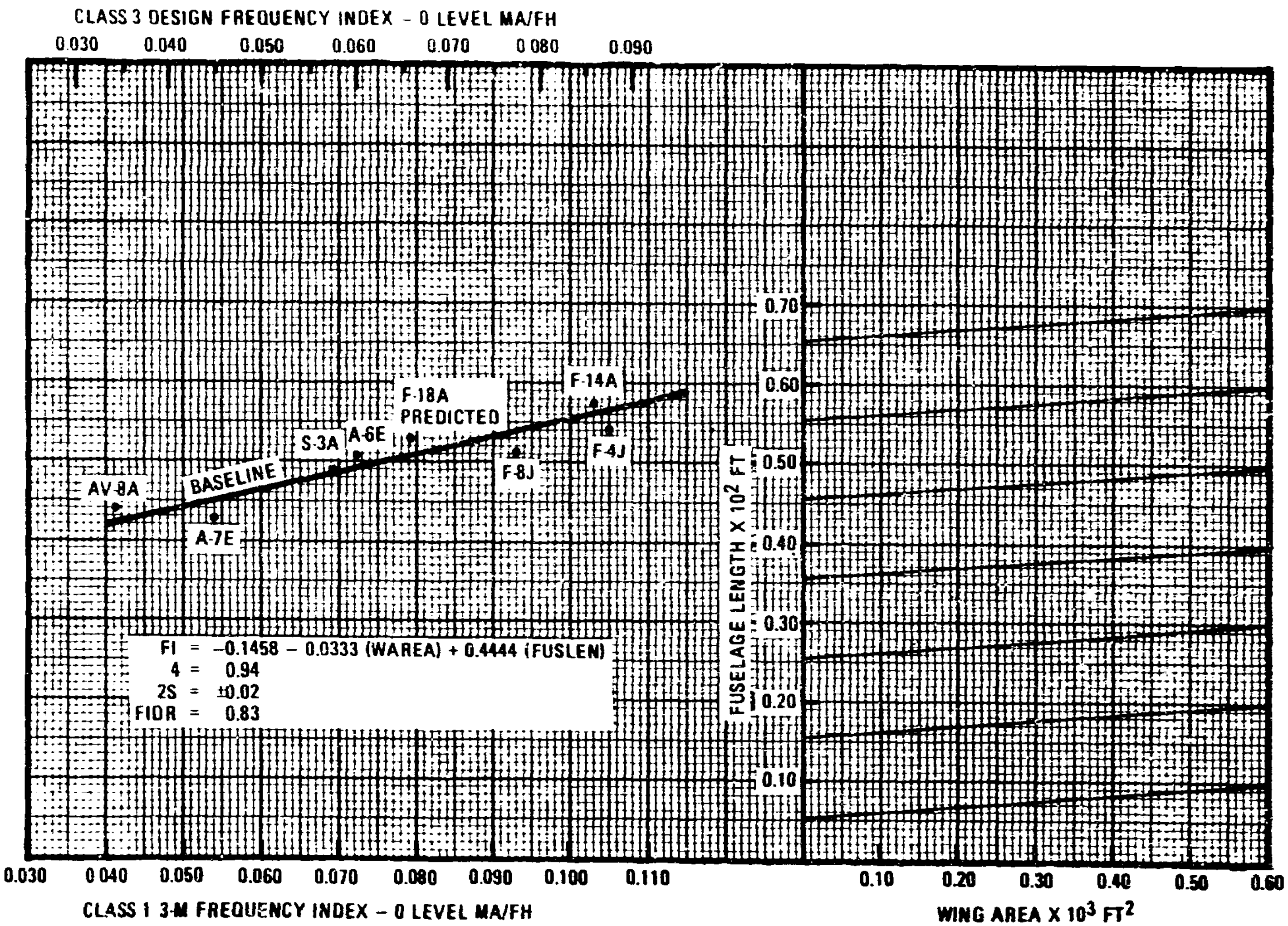


Figure 5.9-2 WUC 44 Frequency Index Graph

WUC: 44 CONTRACTOR:

SYSTEM: Lighting AIRCRAFT MODEL:

PART I CONTRACTOR DATA

CONTRACTOR PREDICTIONS – CLASS 3 DESIGN MAINT. REQ.				
ML	MMH/FH	MA/FH	MMH/MA	EMT/MA
O				
I				

DESIGN/PERFORMANCE PARAMETERS	
Wing Area, Square Feet Fuselage Length, Feet	

PART II SYSTEM CONSTANTS

PARAMETER		BASE	PRED
MEN_O	AVG NO. MEN – O LEVEL	1.6	
MEN_I	AVG NO. MEN – I LEVEL	1.3	
MIIR	MMH/FH I LEVEL RATIO	.25	
FIIR	MA/FH I LEVEL RATIO	.09	

PART III SYSTEM ANALYSIS

PARAMETER	CALCULATION	BASELINE CLASS 1 3-M DATA (A)	PREDICTED CLASS 1 3-M DATA (B)	IMPROVEMENT (DEGRADATION) (C) Δ	%
MMH/FH_O (1)	MAINT. INDEX GRAPH				
	BASELINE				
	PREDICTED				
MA/FH_O (2)	FREQ. INDEX GRAPH				
	BASELINE				
	PREDICTED				
MMH/MA_O (3)	$MMH/FH_O \div MA/FH_O$				
	÷				
	÷				
EMT/MA_O (4)	$MMH/MA_O \div MEN_O$				
	÷				
	÷				
MMH/FH_I (5)	MMH/FH_O X MIIR				
	X				
	X				
MA/FH_I (6)	MA/FH_O X FIIR				
	X				
	X				
MMH/MA_I (7)	$MMH/FH_I \div MA/FH_I$				
EMT/MA_I (8)	MMH/MA_I MEN_I				
$MMH/FH_{O,I}$ (9)	$MMH/FH_O + MMH/FH_I$				

FIGURE 5.9-3 Worksheet for Evaluating System Maintenance Requirements

5.10 HYDRAULICS SYSTEM - WUC 45

Selected Parameters: Empty weight and maximum speed.

Number of Regression Equations Run: 11

Parameters Considered and Rejected: Maximum takeoff weight.

Comments: Hydraulic system maintenance is a function of empty weight and maximum speed at altitude. High performance fighter aircraft tend to require from two to four times the maintenance (MMH/FH) than subsonic attack/ASW aircraft.

The A-4M and F-8J were eliminated from the MA/FH analysis because of poor regression correlation.

TABLE 5.10-1 TWO-DIGIT WUC MAINTENANCE DATA SUMMARY

WUC: 45 SYSTEM: Hydraulics

ACFT	O LEVEL					I LEVEL					TOTAL
	MMH/FH	MA/FH	MMH/MA	EMT/MA	MEN	MMH/FH	MA/FH	MMH/MA	EMT/MA	MEN	MMH/FH
CLASS 1 MAINTENANCE - 3M											
A4M	.085	.018	4.78	2.54	1.9	.009	.002	3.76	2.34	1.6	.094
A6E	.279	.041	6.80	3.84	1.8	.024	.006	3.53	3.25	1.1	.303
A7E	.146	.040	3.66	2.03	1.8	.039	.018	2.22	2.00	1.1	.185
AV8A	.243	.038	6.34	3.34	1.9	.025	.006	4.16	2.44	1.7	.268
F4J	.518	.060	8.64	4.34	2.0	.046	.012	3.89	3.13	1.2	.564
F8J	.350	.081	4.32	2.57	1.7	.074	.018	3.93	3.67	1.1	.424
F14A	.625	.069	9.07	3.80	2.4	.057	.007	7.92	5.34	1.5	.682
S3A	.156	.028	5.50	2.78	2.0	.015	.005	2.82	2.17	1.3	.171
CLASS 3 MAINTENANCE - DESIGN EQUIVALENT											
A4M	.043	.013	3.32	1.65	2.0	.005	.002	2.66	1.60	1.7	.048
A6E	.139	.029	4.79	2.32	2.1	.013	.006	2.22	1.71	1.3	.152
A7E	.078	.033	2.36	1.25	1.9	.029	.018	1.59	1.39	1.1	.106
AV8A	.109	.023	4.76	2.23	2.1	.018	.006	2.94	1.80	1.6	.127
F4J	.299	.047	6.36	2.86	2.2	.031	.012	2.62	2.13	1.2	.331
F8J	.187	.066	2.84	1.59	1.8	.047	.017	2.77	2.58	1.1	.235
F14A	.285	.046	6.20	2.45	2.5	.030	.006	5.00	3.65	1.4	.315
S3A	.066	.016	4.12	1.85	2.2	.010	.005	2.00	1.56	1.3	.076

TABLE 5.10-2 REGRESSION ANALYSIS SUMMARY

WUC: 45 SYSTEM: Hydraulics

MAINTENANCE INDEX ESTIMATION - MMH/FH O LEVEL

ACFT	3M MI		ERROR	WEIGHT EMPTY X 10^3 LBS (WTMT)	MAXIMUM SPEED X 10^3 KNOTS (VMAX)
	ACTUAL	CALCULATED			
A4M	.085	.140	-.055	10.4	.537
A6E	.279	.226	.053	26.0	.490
A7E	.146	.184	-.038	18.9	.506
AV8A	.243	.146	.097	12.0	.525
F4J	.518	.529	.011	30.8	1.230
F8J	.350	.368	-.018	19.8	.989
F14A	.625	.609	.016	38.2	1.314
S3A	.156	.200	-.044	26.6	.410

STATISTICAL PARAMETERS:

REGRESSION EQUATION	MI =	-0.1260 + 0.0066 (WTMT) +0.3671 (VMAX)
CORRELATION COEFFICIENT	r =	0.9604
STANDARD ERROR OF ESTIMATE	S =	0.0624
CONFIDENCE LEVEL, 95%	2S =	±0.1246
NUMBER OF OBSERVATIONS	N =	8

FREQUENCY INDEX ESTIMATION - MA/FH O LEVEL

ACFT	3M FI		ERROR	MAXIMUM SPEED X 10^3 KNOTS (VMAX)	
	ACTUAL	CALCULATED			
A6E	.041	.0368	.0043	.490	
A7E	.040	.0373	.0027	.506	
AV8A	.038	.0381	.0080	.525	
F4J	.060	.0635	-.0035	1.230	
F14A	.069	.0665	.0025	1.314	
S3A	.028	.0339	-.0059	.410	

STATISTICAL PARAMETERS:

REGRESSION EQUATION	FI =	0.0191 + 0.0361 (VMAX)
CORRELATION COEFFICIENT	r =	0.9663
STANDARD ERROR OF ESTIMATE	S =	0.0044
CONFIDENCE LEVEL, 95%	2S =	±0.0088
NUMBER OF OBSERVATIONS	N =	6

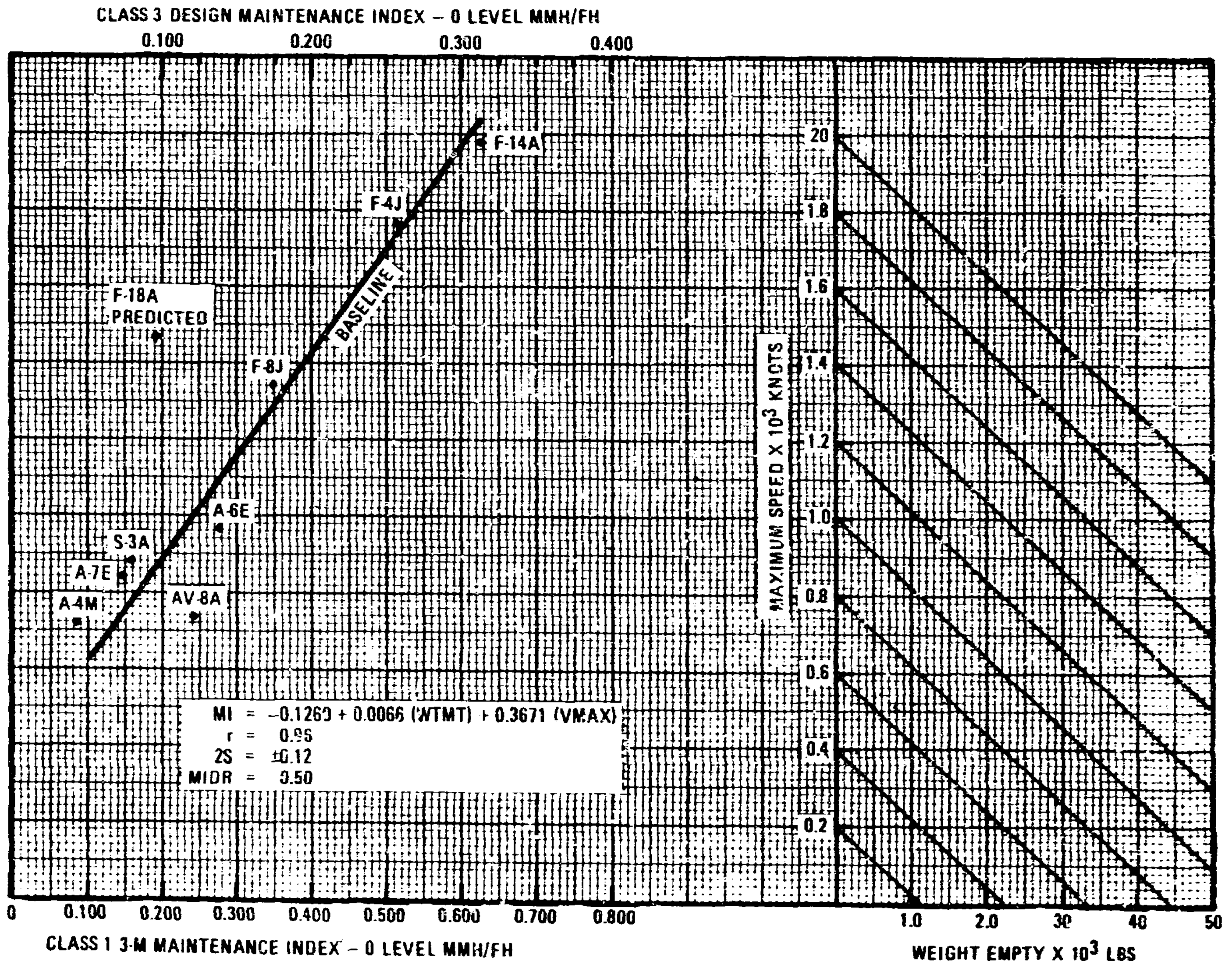


Figure 5.10-1 WUC 45 Maintenance Index Graph

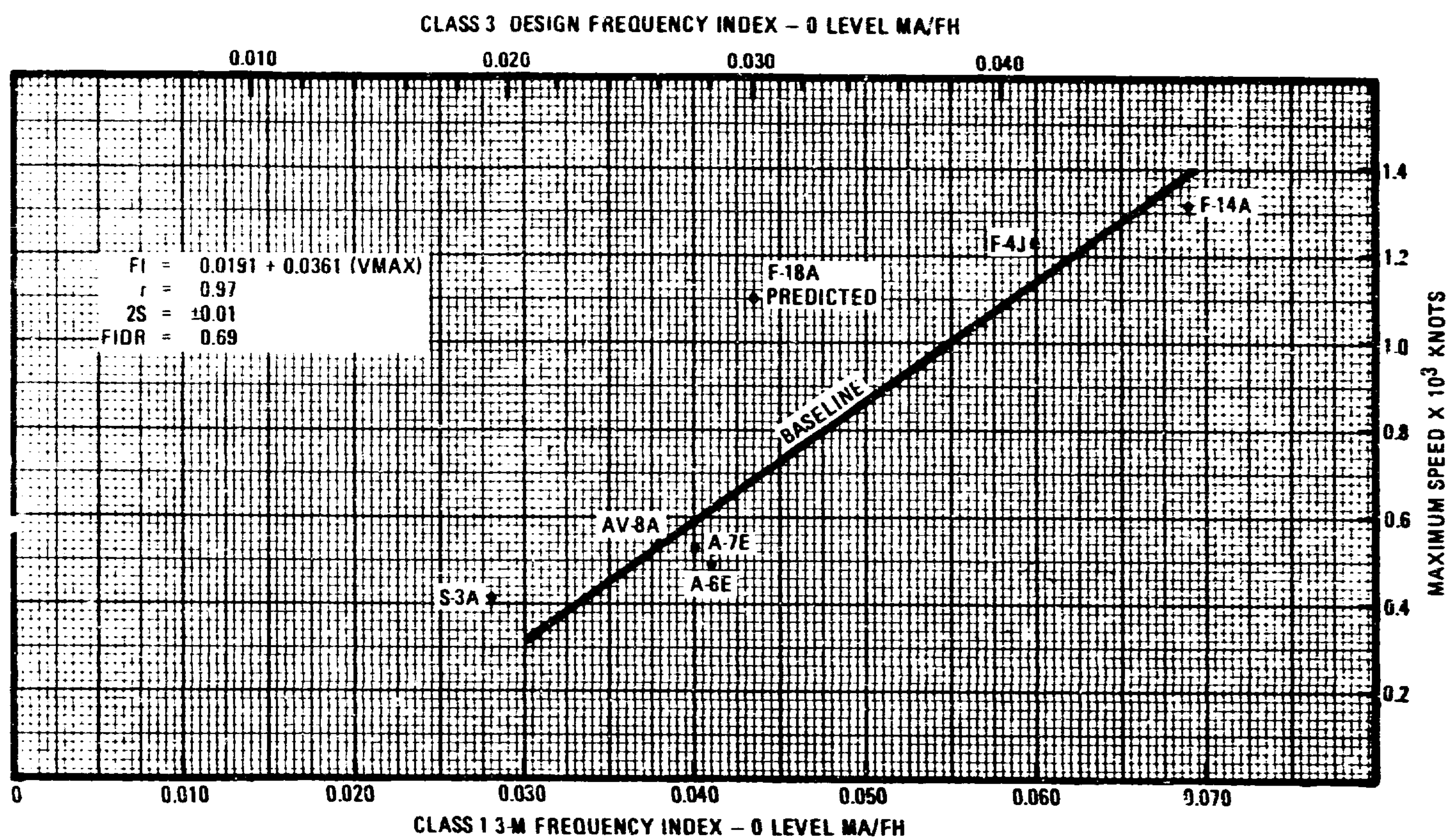


Figure 5.10-2 WUC 45 Frequency Index Graph

WUC. 45 CONTRACTOR:

SYSTEM: Hydraulics AIRCRAFT MODEL:

PART I CONTRACTOR DATA

CONTRACTOR PREDICTIONS – CLASS 3 DESIGN MAINT. REQ.				
ML	MMH/FH	MA/FH	MMH/MA	EMT/MA
O				
I				

DESIGN/PERFORMANCE PARAMETERS	
Weight Empty, lbs. Maximum Speed, knots	

PART II SYSTEM CONSTANTS

PARAMETER		BASE	PRED
MEN_O	AVG NO. MEN – O LEVEL	1.9	
MEN_I	AVG NO. MEN – I LEVEL	1.3	
MIIR	MMH/FH I LEVEL RATIO	.13	
FIIR	MA/FH I LEVEL RATIO	.20	

PART III SYSTEM ANALYSIS

PARAMETER	CALCULATION	BASELINE CLASS 1 3-M DATA (A)	PREDICTED CLASS 1 3-M DATA (B)	IMPROVEMENT (DEGRADATION) (C) Δ	%
MMH/FH_O (1)	MAINT. INDEX GRAPH				
	BASELINE				
	PREDICTED				
MA/FH_O (2)	FREQ. INDEX GRAPH				
	BASELINE				
	PREDICTED				
MMH/MA_O (3)	$MMH/FH_O \div MA/FH_O$				
	÷				
EMT/MA_O (4)	$MMH/MA_O \div MEN_O$				
	÷				
	÷				
MMH/FH_I (5)	MMH/FH_O X MIIR				
	X				
	X				
MA/FH_I (6)	MA/FH_O X FIIR				
	X				
	X				
MMH/MA_I (7)	$MMH/FH_I \div MA/FH_I$				
EMT/MA_I (8)	$MMH/MA_I \div MEN_I$				
	÷				
	÷				
$MMH/FH_{O,I}$ (9)	$MMH/FH_O + MMH/FH_I$				

FIGURE 5.10-3 Worksheet for Evaluating System Maintenance Requirements

5.11 FUEL SYSTEM - WUC 46

Selected Parameters: Fuel capacity and maximum speed.

Number of Regression Equations Run: 19

Parameters Considered and Rejected: Number of fuel tanks, empty weight and maximum takeoff weight.

Comments: Fuel system maintenance is a function of internal fuel capacity and maximum speed at altitude. High performance fighter aircraft tend to require from two to four times the maintenance (MMH/FH) than subsonic attack/ASW aircraft.

The AV-8A was not used due to high maintenance. The wing and engine must be removed for access to some tanks and hardware.

The A-6E was eliminated from the MA/FH analysis due to poor regression correlation.

TABLE 5.11-1 TWO-DIGIT WUC MAINTENANCE DATA SUMMARY

WUC: 46 SYSTEM: Fuel

ACFT	CLASS 1 MAINTENANCE - 3M										
	O LEVEL					I LEVEL					TOTAL
	MMH/FH	MA/FH	MMH/MA	EMT/MA	MEN	MMH/FH	MA/FH	MMH/MA	EMT/MA	MEN	MMH/FH
A4M	.146	.034	4.29	2.01	2.1	.001	.003	.33	.33	1.0	.147
A6E	.280	.061	4.58	2.37	1.9	.013	.008	1.49	1.34	1.1	.293
A7E	.196	.026	7.56	3.33	2.3	.022	.004	5.22	2.94	1.8	.218
AV8A	.449	.072	6.22	3.28	1.9	.026	.013	2.10	1.87	1.1	.475
F4J	.770	.058	13.27	5.61	2.4	.027	.009	3.03	2.34	1.3	.797
F8J	.387	.055	7.70	3.70	1.9	.009	.007	1.34	1.21	1.1	.396
F14A	.734	.069	10.68	4.83	2.2	.015	.007	2.05	1.39	1.5	.749
S3A	.152	.024	6.30	3.33	1.9	.002	.004	.57	.56	1.0	.154
	CLASS 3 MAINTENANCE - DESIGN EQUIVALENT										
A4M	.062	.022	2.83	1.31	2.1	.002	.003	.51	.35	1.4	.064
A6E	.128	.040	3.20	1.59	2.0	.010	.008	1.20	1.02	1.2	.138
A7E	.084	.017	4.94	2.03	2.4	.015	.004	3.70	2.12	1.7	.099
AV8A	.219	.054	4.06	1.97	2.0	.019	.012	1.61	1.39	1.1	.239
F4J	.370	.038	9.73	3.72	2.6	.016	.008	2.05	1.60	1.3	.386
F8J	.200	.039	5.12	2.44	2.1	.007	.006	1.09	.90	1.2	.206
F14A	.333	.047	7.09	3.00	2.3	.010	.007	1.49	1.00	1.5	.344
S3A	.054	.013	4.13	2.07	2.0	.003	.004	.66	.53	1.2	.056

TABLE 5.11-2 REGRESSION ANALYSIS SUMMARY

WUC: 46 SYSTEM: Fuel

MAINTENANCE INDEX ESTIMATION - MMH/FH O LEVEL

ACFT	3M MI		ERROR	FUEL CAPACITY X 10^3 GALS (FUEL)	MAXIMUM SPEED X 10^3 KNOTS (VMAX)
	ACTUAL	CALCULATED			
A4M	.146	.122	.024	.800	.537
A6E	.280	.271	.009	2.344	.490
A7E	.196	.181	.015	1.476	.506
F4J	.770	.680	.090	1.998	1.230
F8J	.387	.459	-.072	1.348	.989
F14A	.734	.775	-.041	2.382	1.314
S3A	.152	.175	-.023	1.933	.410

STATISTICAL PARAMETERS:

REGRESSION EQUATION	MI = -0.2947 X 0.1148 (FUEL) +0.6060 (VMAX)
CORRELATION COEFFICIENT	r = 0.9806
STANDARD ERROR OF ESTIMATE	S = 0.0640
CONFIDENCE LEVEL, 95%	2S = ±0.1280
NUMBER OF OBSERVATIONS	N = 7

FREQUENCY INDEX ESTIMATION - MA/FH O LEVEL

ACFT	3M FI		ERROR	MAXIMUM SPEED X 10^3 KNOTS (VMAX)	
	ACTUAL	CALCULATED			
A4M	.034	.031	.003	.537	
A7E	.026	.029	-.003	.506	
F4J	.058	.063	-.005	1.230	
F8J	.055	.052	.003	.989	
F14A	.069	.067	.002	1.314	
S3A	.024	.025	-.001	.410	

STATISTICAL PARAMETERS:

REGRESSION EQUATION	FI = 0.0056 + 0.0465 (VMAX)
CORRELATION COEFFICIENT	r = 0.9823
STANDARD ERROR OF ESTIMATE	S = 0.0039
CONFIDENCE LEVEL, 95%	2S = ±0.0078
NUMBER OF OBSERVATIONS	N = 6

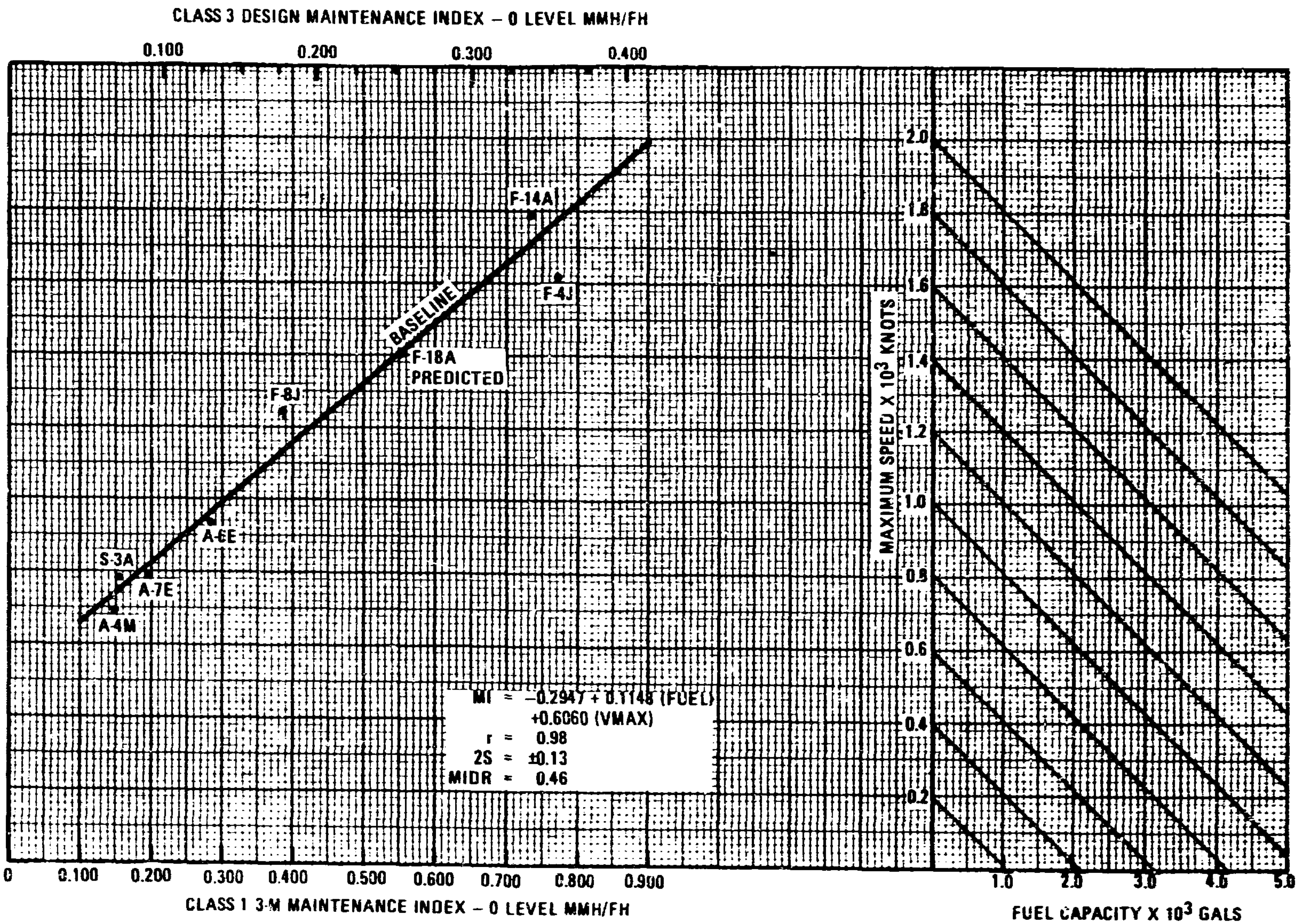


Figure 5.11-1 WUC 46 Maintenance Index Graph

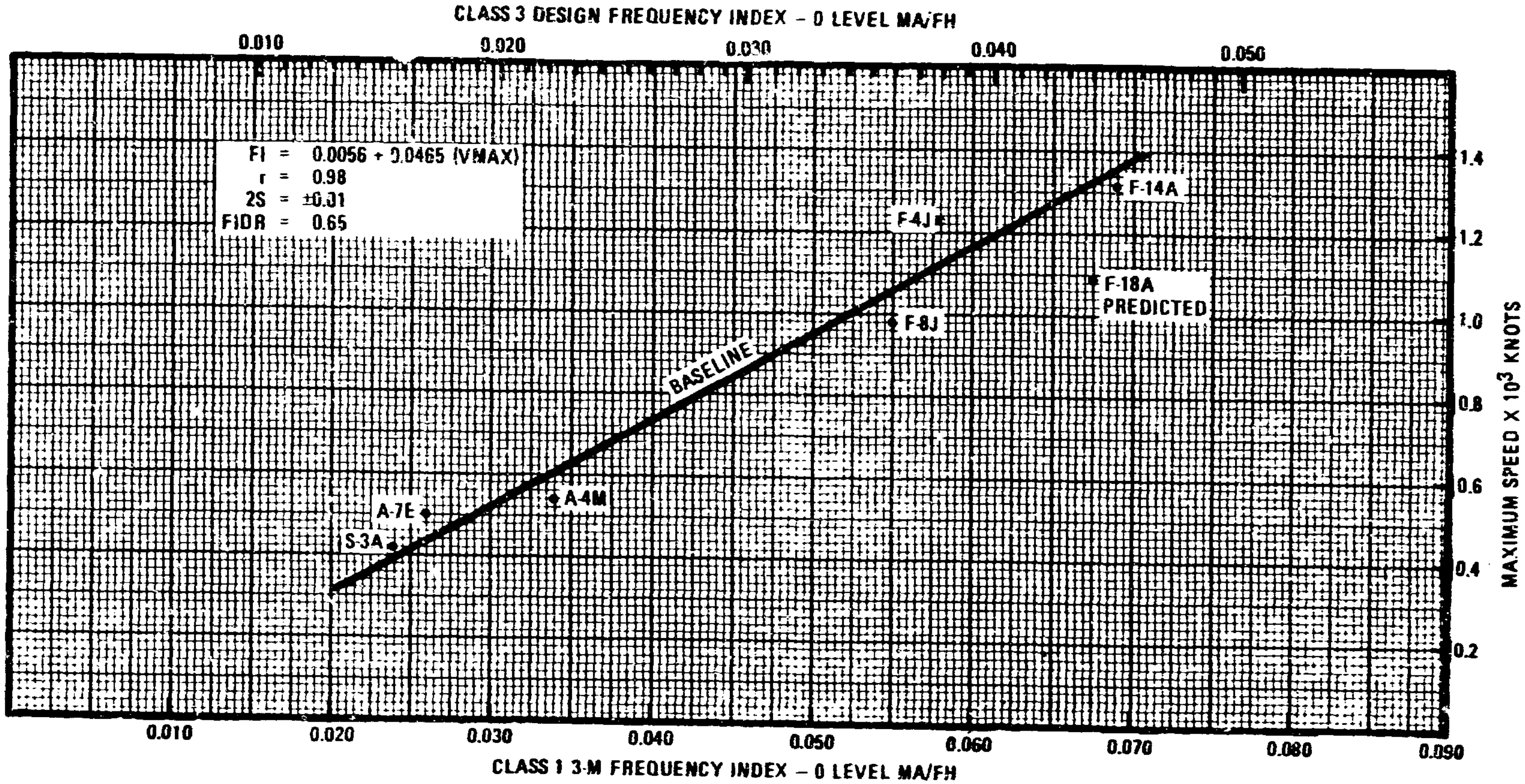


Figure 5.11-2 WUC 46 Frequency Index Graph

WUC: 46 CONTRACTOR: ____________

SYSTEM: Fuel AIRCRAFT MODEL: ____________

PART I CONTRACTOR DATA

CONTRACTOR PREDICTIONS – CLASS 3 DESIGN MAINT. REQ.				
ML	MMH/FH	MA/FH	MMH/MA	EMT/MA
O				
I				

DESIGN/PERFORMANCE PARAMETERS	
Fuel Capacity, gals. Maximum Speed, knots	

PART II SYSTEM CONSTANTS

PARAMETER		BASE	PRED
MEN_O	AVG NO. MEN – O LEVEL	1.9	
MEN_I	AVG NO. MEN – I LEVEL	1.2	
MIIR	MMH/FH I LEVEL RATIO	.04	
FIIR	MA/FH I LEVEL RATIO	.13	

PART III SYSTEM ANALYSIS

PARAMETER	CALCULATION	BASELINE CLASS 1 3-M DATA (A)	PREDICTED CLASS 1 3-M DATA (B)	IMPROVEMENT (DEGRADATION) (C) Δ	%
MMH/FH_O (1)	MAINT. INDEX GRAPH				
	BASELINE				
	PREDICTED				
MA/FH_O (2)	FREQ. INDEX GRAPH				
	BASELINE				
	PREDICTED				
MMH/MA_O (3)	$MMH/FH_O \div MA/FH_O$				
EMT/MA_O (4)	$MMH/MA_O \div MEN_O$				
	÷				
	÷				
MMH/FH_I (5)	MMH/FH_O X MIIR				
	X				
	X				
MA/FH_I (6)	MA/FH_O X FIIR				
	X				
	X				
MMH/MA_I (7)	$MMH/FH_I \div MA/FH_I$				
	÷				
	÷				
EMT/MA_I (8)	$MMH/MA_I \div MEN_I$				
	÷				
	÷				
$MMH/FH_{O,I}$ (9)	$MMH/FH_O + MMH/FH_I$				

FIGURE 5.11-3 Worksheet for Evaluating System Maintenance Requirements

5.12 OXYGEN SYSTEM - WUC 47

Selected Parameters: None.

Number of Regression Equations Run: 11

Parameters Considered and Rejected: Flight hours per aircraft per year, flight length, crew size and service ceiling.

Comments: A satisfactory regression correlation was not obtained for either MMH/FH or MA/FH. Index constants were established by averaging the data from Table 5.12-1.

A Maintenance Index of 0.035 MMH/FH was determined by averaging Class 1 O-level MMH/FH. A Frequency Index of 0.019 MA/FH was determined by averaging Class 1 O-level MA/FH. Given these two parameters, the remaining Class 1 Baseline parameters can be calculated. Results are shown in Figure 5.12-1.

Using Equation 3.9 of Section 3.0, the Maintenance Index Defect Ratio (MIDR) was found to be 0.58. Similarly, using Equation 3.10, the Frequency Index Defect Ratio (FIDR) was found to be 0.74. Both MIDR and FIDR are used in converting Class 3 contractor predictions to Class 1 predictions.

TABLE 5.12-1 TWO-DIGIT WUC MAINTENANCE DATA SUMMARY

WUC: 47 SYSTEM: Oxygen

ACFT	CLASS 1 MAINTENANCE - 3M										
	O LEVEL					I LEVEL					TOTAL
	MMH/FH	MA/FH	MMH/MA	EMT/MA	MEN	MMH/FH	MA/FH	MMH/MA	EMT/MA	MEN	MMH/FH
A4M	.026	.016	1.62	1.22	1.3	.054	.006	9.00	7.73	1.1	.080
A6E	.035	.021	1.68	1.24	1.3	.034	.008	4.17	3.36	1.2	.069
A7E	.024	.014	1.75	1.28	1.4	.021	.004	4.66	4.39	1.1	.045
AV8A	.059	.026	2.27	1.61	1.4	.055	.007	7.68	7.37	1.0	.114
F4J	.034	.028	1.20	.94	1.3	.038	.006	5.75	4.93	1.2	.072
F8J	.047	.015	3.13	2.39	1.3	.005	.004	1.25	1.20	1.0	.052
F14A	.026	.017	1.53	1.06	1.4	.020	.007	2.78	2.63	1.0	.046
S3A	.025	.013	1.95	1.35	1.4	.025	.005	5.27	4.90	1.1	.050
	CLASS 3 MAINTENANCE - DESIGN EQUIVALENT										
A4M	.011	.011	1.03	.88	1.2	.026	.005	5.14	4.55	1.1	.037
A6E	.018	.015	1.22	.87	1.4	.016	.006	2.70	2.20	1.2	.035
A7E	.013	.011	1.22	.87	1.4	.013	.004	3.36	3.15	1.1	.027
AV8A	.034	.021	1.63	1.08	1.5	.026	.005	5.12	4.95	1.0	.060
F4J	.020	.022	.91	.71	1.3	.024	.006	4.01	3.45	1.1	.044
F8J	.025	.011	2.30	1.71	1.3	.003	.003	1.13	.98	1.1	.029
F14A	.014	.013	1.10	.76	1.4	.012	.006	2.08	1.91	1.1	.027
S3A	.011	.008	1.37	.95	1.4	.015	.004	3.78	3.52	1.1	.026

WUC: 47 CONTRACTOR: ______
SYSTEM: Oxygen AIRCRAFT MODEL: ______

PART I CONTRACTOR DATA

CONTRACTOR PREDICTIONS – CLASS 3 DESIGN MAINT. REQ.				
ML	MMH/FH	MA/FH	MMH/MA	EMT/MA
O				
I				

DESIGN/PERFORMANCE PARAMETERS	
None	

PART II SYSTEM CONSTANTS

PARAMETER		BASE	PRED
MEN_O	AVG NO. MEN – O LEVEL	1.3	
MEN_I	AVG NO. MEN – I LEVEL	1.1	
MIIR	MMH/FH I LEVEL RATIO	.98	
FIIR	MA/FH I LEVEL RATIO	.37	

PART III SYSTEM ANALYSIS

PARAMETER	CALCULATION	BASELINE CLASS 1 3-M DATA (A)	PREDICTED CLASS 1 3-M DATA (B)	IMPROVEMENT (DEGRADATION) (C) Δ	%
MMH/FH_O (1)	MAINT. INDEX GRAPH				
	BASELINE				
	PREDICTED				
MA/FH_O (2)	FREQ. INDEX GRAPH				
	BASELINE				
	PREDICTED				
MMH/MA_O (3)	$MMH/FH_O \div MA/FH_O$				
	÷				
	÷				
EMT/MA_O (4)	$MMH/MA_O \div MEN_O$				
	÷				
	÷				
MMH/FH_I (5)	MMH/FH_O X MIIR				
	X				
	X				
MA/FH_I (6)	MA/FH_O X FIIR				
	X				
	X				
MMH/MA_I (7)	$MMH/FH_I \div MA/FH_I$				
	÷				
	÷				
EMT/MA_I (8)	$MMH/MA_I \div MEN_I$				
	÷				
	÷				
$MMH/FH_{O,I}$ (9)	$MMH/FH_O + MMH/FH_I$				

FIGURE 5.12-1 Worksheet for Evaluating System Maintenance Requirements

5.13 MISCELLANEOUS UTILITIES SYSTEM - WUC 49

Selected Parameters: Empty weight.

Number of Regression Equations Run: 5

Parameters Considered and Rejected: Engine quantity.

Comments: Miscellaneous Utilities comprise such subsystems as Fire Detection, Air Driven Turbine Starter and Flight Recorder and is generally considered a low maintenance system. Type equipment assigned to this system varies considerably between aircraft. Maintenance was found to be primarily a function of aircraft empty weight.

The F-4J was not used due to excessively high maintenance for the air driven turbine subsystem. The F-18A predicted MMH/FH and MA/FH values were too high to be plotted on the index graphs. This is probably due to differences in the subsystems between the F-18A WUC and the Standard WUC used for the regression analysis.

TABLE 5.13-1 TWO-DIGIT WUC MAINTENANCE DATA SUMMARY

WUC: 49 SYSTEM: Miscellaneous Utilities

ACFT	CLASS 1 MAINTENANCE - 3M										
	O LEVEL					I LEVEL					TOTAL
	MMH/FH	MA/FH	MMH/MA	EMT/MA	MEN	MMH/FH	MA/FH	MMH/MA	EMT/MA	MEN	MMH/FH
A4M	.005	.001	3.57	1.96	1.8	.003	-	12.50	12.50	1.0	.008
A6E	.035	.007	4.75	2.59	1.8	.002	.001	8.60	7.90	1.1	.037
A7E	.022	.006	4.09	2.31	1.8	.006	.002	3.35	2.90	1.1	.028
AV8A	.004	.001	6.47	3.73	2.3	.001	.001	2.00	1.05	1.9	.005
F4J	.168	.018	9.56	4.45	2.1	.004	.002	2.02	1.89	1.1	.172
F8J	.038	.004	9.50	4.15	2.3	.001	-	-	-	-	.039
F14A	.084	.013	6.46	3.28	2.0	.008	.002	5.32	3.50	1.5	.092
S3A	.050	.007	7.14	3.45	2.1	.001	.001	1.33	1.00	1.3	.051
	CLASS 3 MAINTENANCE - DESIGN EQUIVALENT										
A4M	.003	.001	2.73	1.44	1.9	-	-	-	-	-	.003
A6E	.015	.005	3.09	1.68	1.8	.003	.001	2.55	2.20	1.1	.018
A7E	.010	.004	2.53	1.36	1.9	.005	.002	2.43	2.09	1.2	.015
AV8A	.003	.001	2.51	2.18	1.1	-	-	-	-	-	.003
F4J	.040	.008	5.04	2.40	2.1	.002	.001	1.60	1.27	1.2	.042
F8J	.017	.004	4.25	2.38	1.8	.002	.001	1.55	1.33	1.2	.019
F14J	.040	.007	5.74	2.32	2.5	.004	.001	4.19	1.67	2.5	.044
S3A	.021	.006	3.44	1.35	2.5	.001	.001	1.13	.81	1.4	.022

TABLE 5.13-2 REGRESSION ANALYSIS SUMMARY

WUC: 49 SYSTEM: Miscellaneous Utilities

MAINTENANCE INDEX ESTIMATION - MMH/FH O LEVEL

ACFT	3M MI		ERROR	WEIGHT EMPTY X 10^3 LBS (WTMT)	
	ACTUAL	CALCULATED			
A4M	.005	.002	.003	10.4	
A6E	.035	.046	-.011	26.0	
A7E	.022	.026	-.004	18.9	
AV8A	.004	.006	-.002	12.0	
F8J	.038	.029	.009	19.8	
F14A	.084	.081	.003	38.2	
S3A	.050	.048	.002	26.6	

STATISTICAL PARAMETERS:

REGRESSION EQUATION	MI =	0.0275 + 0.0028 (WTMT)
CORRELATION COEFFICIENT	r =	0.9717
STANDARD ERROR OF ESTIMATE	S =	0.0072
CONFIDENCE LEVEL, 95%	2S =	±0.0144
NUMBER OF OBSERVATIONS	N =	7

FREQUENCY INDEX ESTIMATION - MA/FH O LEVEL

ACFT	3M FI		ERROR	WEIGHT EMPTY X 10^3 LBS (WTMT)	
	ACTUAL	CALCULATED			
A4M	.001	.0007	.0003	10.4	
A6E	.007	.0074	-.0004	26.0	
A7E	.006	.0044	.0016	18.9	
AV8A	.001	.0014	-.0004	12.0	
F8J	.004	.0047	.0007	19.8	
F14A	.013	.0126	.0004	38.2	
S3A	.007	.0076	-.0006	26.6	

STATISTICAL PARAMETERS:

REGRESSION EQUATION	FI =	-0.0036 + 0.0004 (WTMT)
CORRELATION COEFFICIENT	r =	0.9795
STANDARD ERROR OF ESTIMATE	S =	0.0009
CONFIDENCE LEVEL, 95%	2S =	±0.0018
NUMBER OF OBSERVATIONS	N =	7

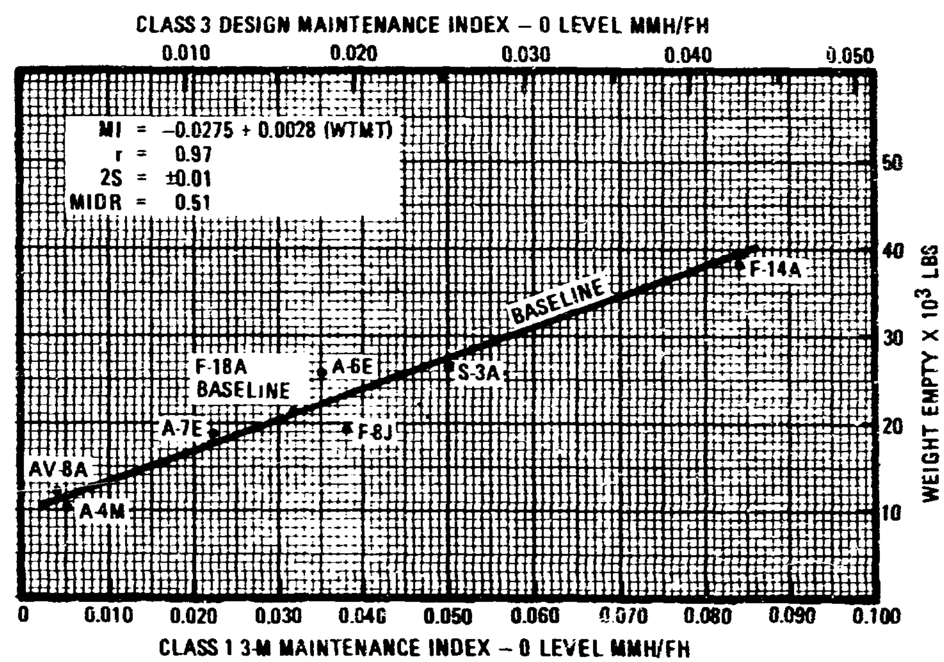


Figure 5.13-1 WUC 49 Maintenance Index Graph

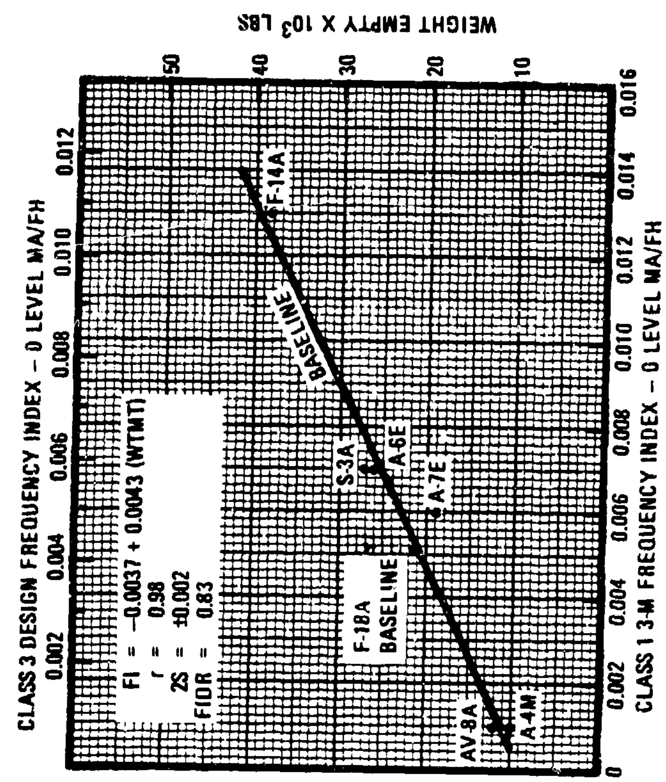


Figure 5.13-2 WUC 49 Frequency Index Graph

WUC: 49 CONTRACTOR: ___

SYSTEM: Miscellaneous Utilities AIRCRAFT MODEL: ___

PART I CONTRACTOR DATA

CONTRACTOR PREDICTIONS – CLASS 3 DESIGN MAINT. REQ.				
ML	MMH/FH	MA/FH	MMH/MA	EMT/MA
O				
I				

DESIGN/PERFORMANCE PARAMETERS	
Weight Empty, lbs.	

PART II SYSTEM CONSTANTS

PARAMETER		BASE	PRED
MEN_O	AVG NO. MEN – O LEVEL	2.0	
MEN_I	AVG NO. MEN – I LEVEL	1.3	
MIIR	MMH/FH I LEVEL RATIO	.19	
FIIR	MA/FH I LEVEL RATIO	.35	

PART III SYSTEM ANALYSIS

PARAMETER	CALCULATION	BASELINE CLASS 1 3-M DATA (A)	PREDICTED CLASS 1 3-M DATA (B)	IMPROVEMENT (DEGRADATION) (C) Δ	%
MMH/FH_O (1)	MAINT. INDEX GRAPH				
	BASELINE				
	PREDICTED				
MA/FH_O (2)	FREQ. INDEX GRAPH				
	BASELINE				
	PREDICTED				
MMH/MA_O (3)	$MMH/FH_O \div MA/FH_O$				
EMT/MA_O (4)	$MMH/MA_O \div MEN_O$				
MMH/FH_I (5)	$MMH/FH_O \times MIIR$				
	x				
	x				
MA/FH_I (6)	$MA/FH_O \times FIIR$				
	x				
	x				
MMH/MA_I (7)	$MMH/FH_I \div MA/FH_I$				
EMT/MA_I (8)	$MMH/MA_I \div MEN_I$				
	÷				
	÷				
$MMH/FH_{O,I}$ (9)	$MMH/FH_O + MMH/FH_I$				

FIGURE 5.13-3 Worksheet for Evaluating System Maintenance Requirements

5.14 INSTRUMENTS SYSTEM - WUC 51

Selected Parameters: Avionics weight uninstalled.

Number of Regression Equations Run: 5

Parameters Considered and Rejected: Avionics weight installed and empty weight.

Comments: The design parameter having the greatest influence on Instrument System maintenance was uninstalled avionics weight. As aircraft avionics weight increased, so did instrument maintenance. Five aircraft were used in the regression analysis with the other three rejected for the following reasons.

S-3A actual maintenance (MMH/FH) ran 62% less than the calculated value based on its given avionics weight. One reason for this can be attributed to improved instrumentation design especially in wiring and cockpit gauges. S-3A fuel quantity indication subsystem maintenance was five times less than the F-14A and three times less than the A-7E and AV-8A. Flight/navigation instrument maintenance was half the F-4J and five times better than the A-6E. At I-level, S-3A maintenance was as low as the less complex A-4M.

The AV-8A on the other hand required 2.5 times more maintenance than its calculated value. Higher than normal maintenance showed up in fuel quantity indication and flight/navigation instruments.

The F-8J also required 2.5 times the maintenance for its given avionics weight. Problems with flight/navigation instruments caused the F-8J to require as much maintenance as the more complex, two-seat A-6E.

TABLE 5.14-1 TWO-DIGIT WUC MAINTENANCE DATA SUMMARY

WUC: 51 SYSTEM: Instruments

ACFT	CLASS 1 MAINTENANCE - 3M										
	O LEVEL					I LEVEL					TOTAL
	MMH/FH	MA/FH	MMH/MA	EMT/MA	MEN	MMH/FH	MA/FH	MMH/MA	EMT/MA	MEN	MMH/FH
A4M	.210	.057	3.68	1.93	1.9	.026	.015	1.73	1.12	1.5	.236
A6E	.593	.155	3.82	2.25	1.7	.119	.050	2.38	1.97	1.2	.712
A7E	.412	.089	4.62	2.42	1.9	.043	.027	1.60	1.47	1.1	.455
AV8A	.451	.107	4.21	2.22	1.9	.045	.025	1.80	1.39	1.3	.496
F4J	.471	.106	4.44	2.34	1.9	.045	.026	1.70	1.34	1.2	.516
F8J	.652	.184	3.54	2.14	1.6	.134	.068	1.97	1.61	1.2	.786
F14A	.788	.133	5.92	2.70	2.2	.240	.041	5.85	4.39	1.3	1.028
S3A	.376	.101	3.72	1.41	2.6	.026	.028	.93	.77	1.2	.402
	CLASS 3 MAINTENANCE - DESIGN EQUIVALENT										
A4M	.100	.040	2.50	1.31	1.9	.016	.013	1.25	.82	1.5	.116
A6E	.258	.088	2.93	1.58	1.8	.074	.040	1.84	1.27	1.4	.332
A7E	.193	.061	3.17	1.56	2.0	.030	.023	1.31	1.16	1.1	.224
AV8A	.190	.073	2.60	1.35	1.9	.029	.021	1.39	1.05	1.3	.219
F4J	.237	.077	3.08	1.45	2.1	.028	.022	1.26	.95	1.3	.265
F8J	.315	.131	2.40	1.35	1.8	.079	.052	1.52	1.18	1.3	.394
F14A	.370	.085	4.35	1.82	2.4	.148	.034	4.36	3.43	1.3	.518
S3A	.143	.053	2.69	1.38	1.9	.024	.028	.85	.70	1.2	.166

TABLE 5.14-2 REGRESSION ANALYSIS SUMMARY

WUC: 51 SYSTEM: Instruments

MAINTENANCE INDEX ESTIMATION - MMH/FH O LEVEL

ACFT	3M MI		ERROR	WEIGHT AVIONICS UNINSTALLED X 10^3 LBS (WTAVUN)	
	ACTUAL	CALCULATED			
A4M	.210	.197	.013	.517	
A6E	.593	.604	-.011	1.920	
A7E	.412	.391	.021	1.185	
F4J	.471	.531	-.060	1.669	
F14A	.788	.750	.038	2.422	

STATISTICAL PARAMETERS:

REGRESSION EQUATION	MI =	0.0465 + 0.2906 (WTAVUN)
CORRELATION COEFFICIENT	r =	0.9840
STANDARD ERROR OF ESTIMATE	S =	0.0441
CONFIDENCE LEVEL, 95%	2S =	± .0882
NUMBER OF OBSERVATIONS	N =	5

FREQUENCY INDEX ESTIMATION - MA/FH O LEVEL

ACFT	3M FI		ERROR	WEIGHT AVIONICS UNINSTALLED X 10^3 LBS (WTAVUN)	
	ACTUAL	CALCULATED			
A4M	.057	.060	-.003	.517	
A6E	.155	.126	.029	1.920	
A7E	.089	.091	-.002	1.185	
F4J	.106	.114	-.008	1.669	
F14A	.133	.149	-.016	2.422	

STATISTICAL PARAMETERS:

REGRESSION EQUATION	FI =	0.0360 + 0.0467 (WTAVUN)
CORRELATION COEFFICIENT	r =	0.8907
STANDARD ERROR OF ESTIMATE	S =	0.0199
CONFIDENCE LEVEL, 95%	2S =	±0.0398
NUMBER OF OBSERVATIONS	N =	5

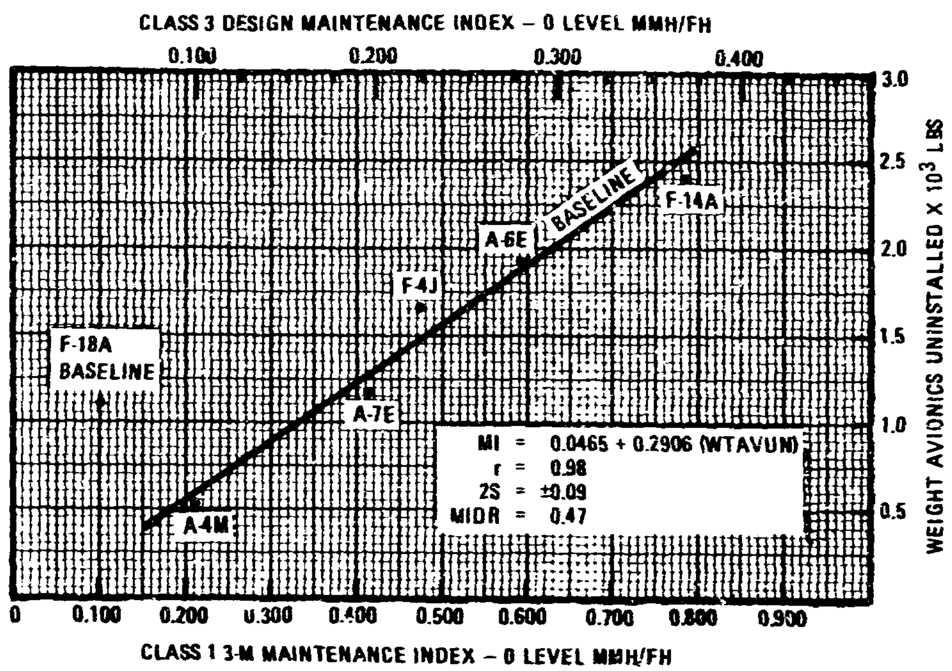


Figure 5.14-1 WUC 51 Maintenance Index Graph

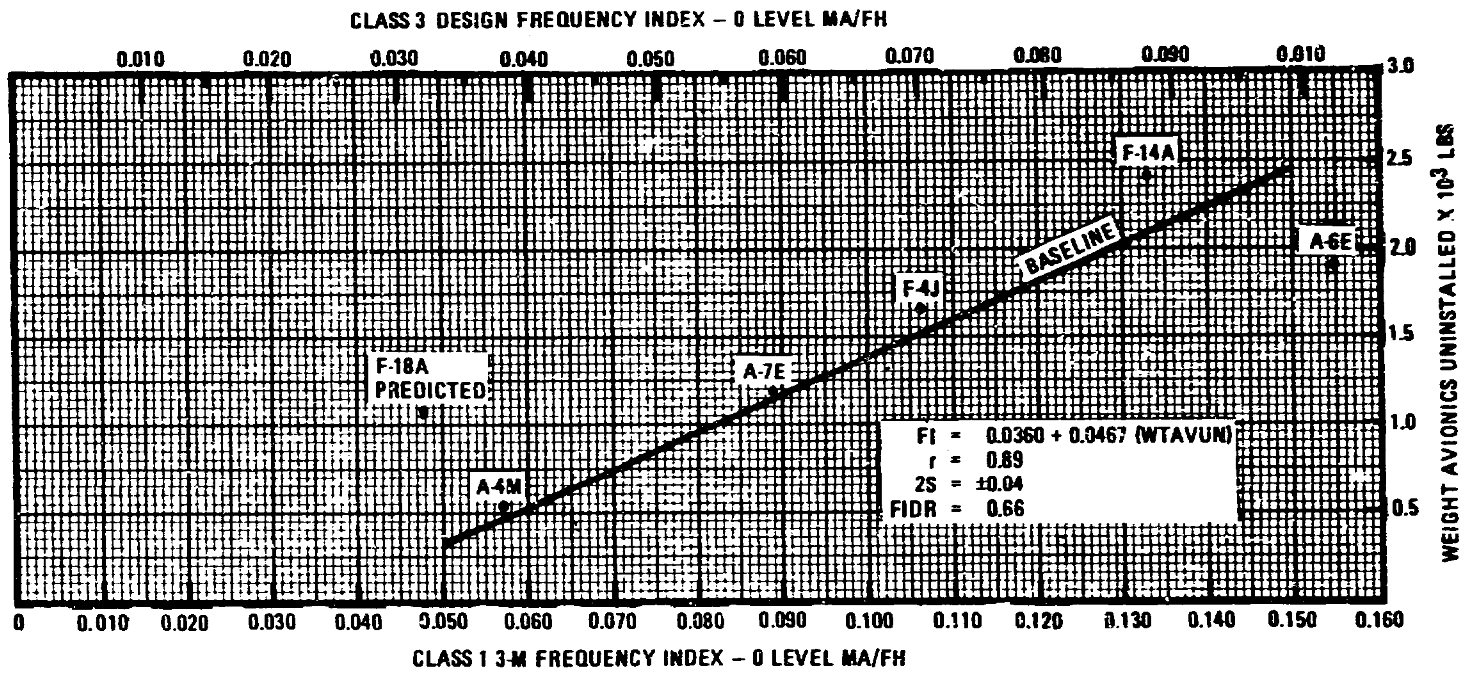


Figure 5.14-2 WUC 51 Frequency Index Graph

WUC: 51 CONTRACTOR: ______

SYSTEM: Instruments AIRCRAFT MODEL: ______

PART I CONTRACTOR DATA

CONTRACTOR PREDICTIONS – CLASS 3 DESIGN MAINT. REQ.				
ML	MMH/FH	MA/FH	MMH/MA	EMT/MA
O				
I				

DESIGN/PERFORMANCE PARAMETERS	
Weight Avionics Uninstalled, lbs.	

PART II SYSTEM CONSTANTS

PARAMETER		BASE	PRED
MEN_O	AVG NO. MEN – O LEVEL	1.9	
MEN_I	AVG NO. MEN – I LEVEL	1.3	
MIIR	MMH/FH I LEVEL RATIO	.16	
FIIR	MA/FH I LEVEL RATIO	.29	

PART III SYSTEM ANALYSIS

PARAMETER	CALCULATION	BASELINE CLASS 1 3-M DATA (A)	PREDICTED CLASS 1 3-M DATA (B)	IMPROVEMENT (DEGRADATION) (C) Δ	%
MMH/FH_O (1)	MAINT. INDEX GRAPH				
	BASELINE				
	PREDICTED				
MA/FH_O (2)	FREQ. INDEX GRAPH				
	BASELINE				
	PREDICTED				
MMH/MA_O (3)	$MMH/FH_O \div MA/FH_O$				
	÷				
	÷				
EMT/MA_O (4)	$MMH/MA_O \div MEN_O$				
	÷				
	÷				
MMH/FH_I (5)	$MMH/FH_O \times MIIR$				
	X				
	X				
MA/FH_I (6)	$MA/FH_O \times FIIR$				
	X				
	X				
MMH/MA_I (7)	$MMH/FH_I \div MA/FH_I$				
	÷				
	÷				
EMT/MA_I (8)	$MMH/MA_I \div MEN_I$				
	÷				
	÷				
$MMH/FH_{O,I}$ (9)	$MMH/FH_O + MMH/FH_I$				

FIGURE 5.14-3 Worksheet for Evaluating System Maintenance Requirements

5.15 FLIGHT REFERENCE SYSTEM - WUC 56

Selected Parameters: Avionics weight installed.

Number of Regression Equations Run: 13

Parameters Considered and Rejected: Empty weight, maximum takeoff weight and avionics weight uninstalled.

Comments: The A-6E and S-3A were eliminated because of poor regression correlation. The actual values for both aircraft were much below the norm and the calculated values. This may be due to deficiencies in the Standard WUC.

TABLE 5.15-1 TWO-DIGIT WUC MAINTENANCE DATA SUMMARY

WUC: 56 SYSTEM: *Flight Reference*

ACFT	CLASS 1 MAINTENANCE - 3M										
	O LEVEL					I LEVEL					TOTAL
	MMH/FH	MA/FH	MMH/MA	EMT/MA	MEN	MMH/FH	MA/FH	MMH/MA	EMT/MA	MEN	MMH/FH
A4M	.045	.009	4.98	2.57	1.9	.005	.003	1.40	1.17	1.2	.050
A6E	.143	.047	3.04	1.77	1.7	.112	.018	6.22	4.21	1.5	.255
A7E	.159	.056	2.85	1.68	1.7	.108	.022	5.00	4.32	1.1	.267
AV8A	.067	.021	3.19	1.79	1.8	.112	.008	13.95	10.16	1.4	.179
F4J	.487	.103	4.72	2.53	1.8	.403	.052	7.78	5.54	1.4	.890
F8J	.094	.038	2.47	1.44	1.7	.047	.016	2.94	2.37	1.2	.141
F14A	.588	.147	3.97	1.82	2.2	.706	.058	12.05	7.14	1.7	1.292
S3A	.140	.046	3.04	1.80	1.7	.126	.014	9.00	5.25	1.7	.266
	CLASS 3 MAINTENANCE - DESIGN EQUIVALENT										
A4M	.019	.005	3.86	1.89	2.0	.004	.003	1.20	.95	1.2	.023
A6E	.051	.024	2.13	1.17	1.8	.067	.015	4.85	3.17	1.5	.118
A7E	.075	.039	1.92	1.09	1.7	.071	.020	3.54	3.06	1.1	.146
AV8A	.029	.013	2.24	1.17	1.9	.072	.007	10.31	7.77	1.3	.101
F4J	.214	.065	3.30	1.64	2.0	.240	.042	5.71	4.17	1.3	.454
F8J	.051	.031	1.65	.95	1.7	.030	.014	2.12	1.80	1.2	.081
F14A	.195	.069	2.83	1.25	2.2	.408	.044	9.28	5.68	1.6	.604
S3A	.044	.022	2.01	1.16	1.7	.078	.013	5.99	3.55	1.7	.122

TABLE 5.15-2 REGRESSION ANALYSIS SUMMARY

WUC: 56 SYSTEM: Flight Reference

MAINTENANCE INDEX ESTIMATION - MMH/FH O LEVEL

ACFT	3M MI		ERROR	WEIGHT AVIONICS INSTALLED X 10^3 LBS (WTAVIN)	
	ACTUAL	CALCULATED			
A4M	.045	.044	.001	.612	
A7E	.159	.205	-.046	1.347	
AV8A	.067	.040	.027	.590	
F4J	.487	.487	.000	2.641	
F8J	.094	.090	.004	.819	
F14A	.588	.574	.014	3.039	

STATISTICAL PARAMETERS:

REGRESSION EQUATION MI = -0.0890 + 0.2182 (WTAVIN)

CORRELATION COEFFICIENT r = 0.9945
STANDARD ERROR OF ESTIMATE S = 0.0276
CONFIDENCE LEVEL, 95% 2S = ±0.0552
NUMBER OF OBSERVATIONS N = 6

FREQUENCY INDEX ESTIMATION - MA/FH O LEVEL

ACFT	3M FI		ERROR	WEIGHT AVIONICS INSTALLED X 10^3 LBS (WTAVIN)	
	ACTUAL	CALCULATED			
A4M	.009	.019	-.010	.612	
A7E	.056	.054	.002	1.347	
AV8A	.021	.018	.003	.590	
F4J	.103	.117	-.014	2.641	
F8J	.038	.029	.009	.819	
F14A	.147	.136	.011	3.039	

STATISTICAL PARAMETERS:

REGRESSION EQUATION FI = -0.0106 + 0.0483 (WTAVIN)

CORRELATION COEFFICIENT r = 0.9818
STANDARD ERROR OF ESTIMATE S = 0.0112
CONFIDENCE LEVEL, 95% 2S = ±0.0224
NUMBER OF OBSERVATIONS N = 6

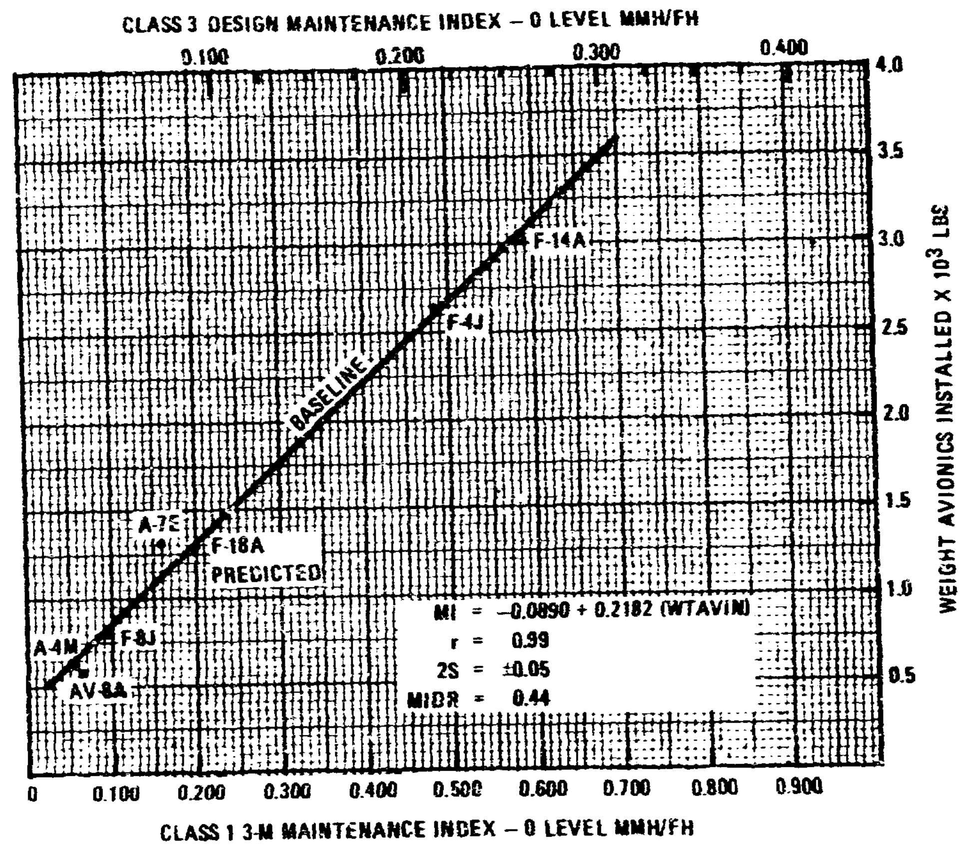


Figure 5.15-1 WUC 56 Maintenance Index Graph

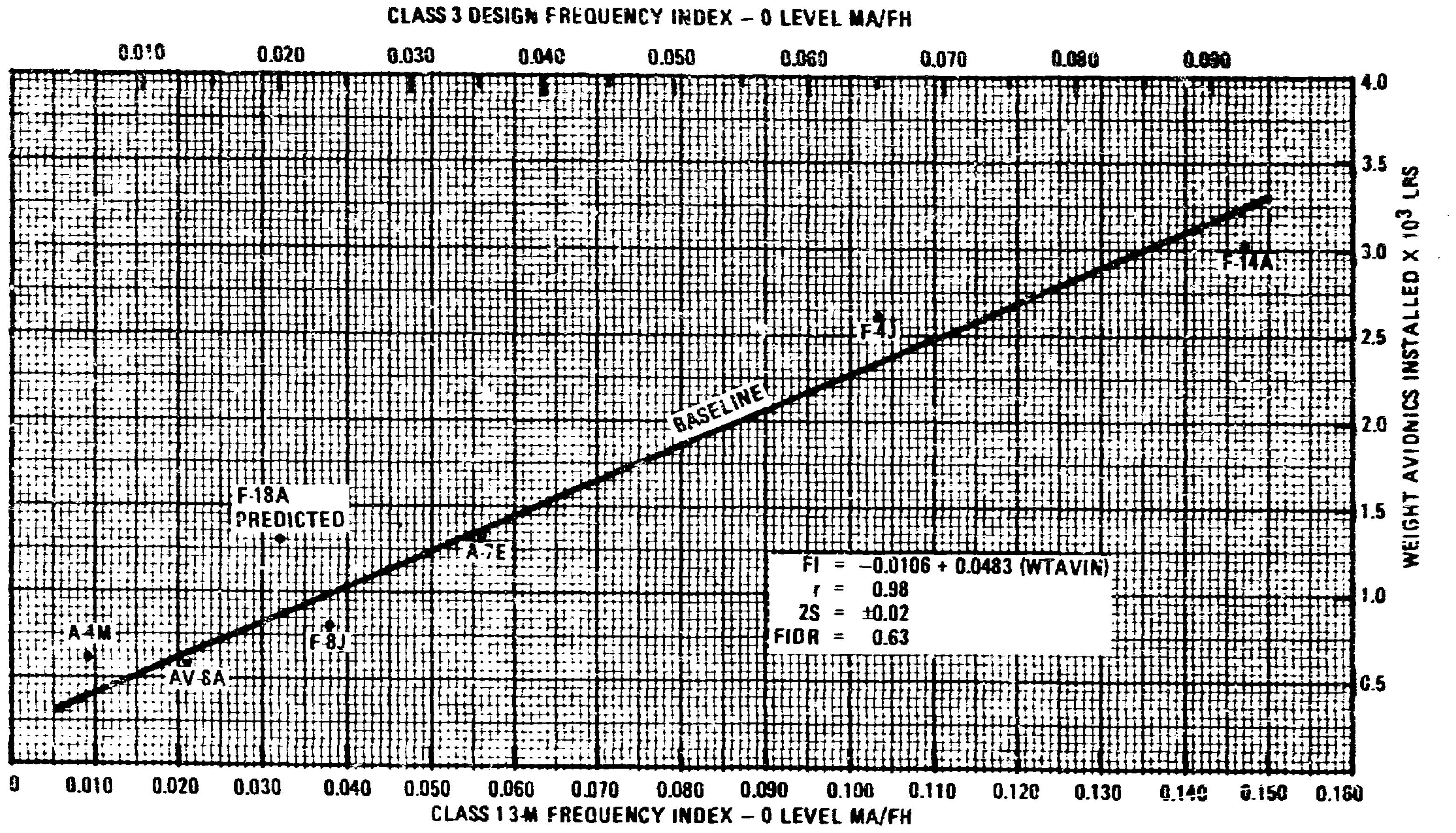


Figure 5.15-2 WUC 56 Frequency Index Graph

WUC: 56 CONTRACTOR:

SYSTEM: Flight Reference AIRCRAFT MODEL:

PART I CONTRACTOR DATA

CONTRACTOR PREDICTIONS – CLASS 3 DESIGN MAINT. REQ.				
ML	MMH/FH	MA/FH	MMH/MA	EMT/MA
O				
I				

DESIGN/PERFORMANCE PARAMETERS	
Weight Avionics Installed, lbs.	

PART II SYSTEM CONSTANTS

PARAMETER		BASE	PRED
MEN_O	AVG NO. MEN – O LEVEL	1.8	
MEN_I	AVG NO. MEN – I LEVEL	1.3	
MIIR	MMH/FH I LEVEL RATIO	.83	
FIIR	MA/FH I LEVEL RATIO	.40	

PART III SYSTEM ANALYSIS

PARAMETER	CALCULATION	BASELINE CLASS 1 3-M DATA (A)	PREDICTED CLASS 1 3-M DATA (B)	IMPROVEMENT (DEGRADATION) (C) Δ	%
MMH/FH_O (1)	MAINT. INDEX GRAPH				
	BASELINE				
	PREDICTED				
MA/FH_O (2)	FREQ. INDEX GRAPH				
	BASELINE				
	PREDICTED				
MMH/MA_O (3)	$MMH/FH_O \div MA/FH_O$				
	÷				
	÷				
EMT/MA_O (4)	$MMH/MA_O \div MEN_O$				
	÷				
	÷				
MMH/FH_I (5)	MMH/FH_O X MIIR				
	X				
	X				
MA/FH_I (6)	MA/FH_O X FIIR				
	X				
	X				
MMH/MA_I (7)	$MMH/FH_I \div MA/FH_I$				
	÷				
	÷				
EMT/MA_I (8)	$MMH/MA_I \div MEN_I$				
	÷				
	÷				
$MMH/FH_{O,I}$ (9)	$MMH/FH_O + MMH/FH_I$				

FIGURE 5.15-3 Worksheet for Evaluating System Maintenance Requirements

5.16 INTEGRATED GUIDANCE AND FLIGHT CONTROLS SYSTEM - WUC 57

Selected Parameters: Empty weight and avionics weight uninstalled.

Number of Regression Equations Run: 12

Parameters Considered and Rejected: Combat weight, maximum takeoff weight and avionics weight installed.

Comments: The A-6E and the F-8J were eliminated due to poor regression correlation. The Standard WUC may not be adequate for these two aircraft.

TABLE 5.16-1 TWO-DIGIT WUC MAINTENANCE DATA SUMMARY

WUC: 57 SYSTEM: Integrated Guidance and Flight Controls

ACFT	CLASS 1 MAINTENANCE - 3M										
	O LEVEL					I LEVEL					TOTAL
	MMH/FH	MA/FH	MMH/MA	EMT/MA	MEN	MMH/FH	MA/FH	MMH/MA	EMT/MA	MEN	MMH/FH
A4M	.056	.011	5.11	2.81	1.8	.020	.004	5.29	3.04	1.7	.076
A6E	.077	.025	3.13	1.73	1.8	.093	.007	13.28	8.27	1.6	.170
A7E	.241	.052	4.62	2.32	2.0	.098	.020	5.00	4.50	1.1	.339
AV8A	.139	.032	4.33	2.42	1.8	.064	.010	6.63	4.67	1.4	.203
F4J	.299	.040	7.40	3.31	2.2	.128	.013	9.45	6.97	1.3	.427
F8J	.707	.131	5.34	2.97	1.8	.243	.055	4.40	3.55	1.2	.950
F14A	.299	.053	5.62	2.50	2.2	.270	.016	16.52	11.17	1.5	.569
S3A	.262	.064	4.10	2.24	1.8	.181	.018	10.09	7.09	1.4	.443
	CLASS 3 MAINTENANCE - DESIGN EQUIVALENT										
A4M	.027	.007	3.89	2.01	1.9	.011	.003	3.68	2.15	1.7	.038
A6E	.035	.016	2.20	1.15	1.9	[illegible]	.005	11.13	7.25	1.5	.091
A7E	.114	.036	3.16	1.47	2.1	.058	.015	3.85	3.48	1.1	.171
AV8A	.063	.022	2.86	1.59	1.8	.038	.007	5.40	4.02	1.3	.101
F4J	.120	.027	4.43	2.06	2.1	.071	.011	6.50	4.79	1.3	.191
F8J	.364	.107	3.40	1.76	1.9	.156	.049	3.17	2.56	1.2	.520
F14A	.107	.023	4.63	1.84	2.5	.149	.011	13.56	9.51	1.4	.256
S3A	.080	.024	3.33	1.73	1.9	.102	.013	7.87	5.66	1.4	.182

TABLE 5.16-2 REGRESSION ANALYSIS SUMMARY

WUC: 57 SYSTEM: Integrated Guidance/Flight Controls

MAINTENANCE INDEX ESTIMATION - MMH/FH O LEVEL

ACFT	3M MI		ERROR	WEIGHT EMPTY X 10^3 LBS (WTMT)	
	ACTUAL	CALCULATED			
A4M	.056	.095	-.039	10.4	
A7E	.241	.202	.039	18.9	
AV8A	.139	.121	.018	12.0	
F4J	.299	.289	.010	30.8	
F14A	.299	.327	.028	38.2	
S3A	.262	.263	-.001	26.6	

STATISTICAL PARAMETERS:

REGRESSION EQUATION	MI =	-0.3225 + 0.1783 ln (WTMT)
CORRELATION COEFFICIENT	r =	0.9540
STANDARD ERROR OF ESTIMATE	S =	0.0328
CONFIDENCE LEVEL, 95%	2S =	±0.0656
NUMBER OF OBSERVATIONS	N =	6

FREQUENCY INDEX ESTIMATION - MA/FH O LEVEL

ACFT	3M FI		ERROR	WEIGHT AVIONICS UNINSTALLED X 10^3 LBS (WTAVUN)	
	ACTUAL	CALCULATED			
A4M	.0110	.0244	-.0134	.517	
A7E	.0520	.0410	.0110	1.185	
AV8A	.0320	.0220	.0100	.460	
F4J	.0400	.0480	-.0080	1.669	
F14A	.0530	.0554	-.0024	2.422	
S3A	.0640	.0612	.0028	3.240	

STATISTICAL PARAMETERS:

REGRESSION EQUATION	FI =	0.0376 + 0.0201 ln (WTAVUN)
CORRELATION COEFFICIENT	r =	0.8555
STANDARD ERROR OF ESTIMATE	S =	0.0109
CONFIDENCE LEVEL, 95%	2S =	±0.0218
NUMBER OF OBSERVATIONS	N =	6

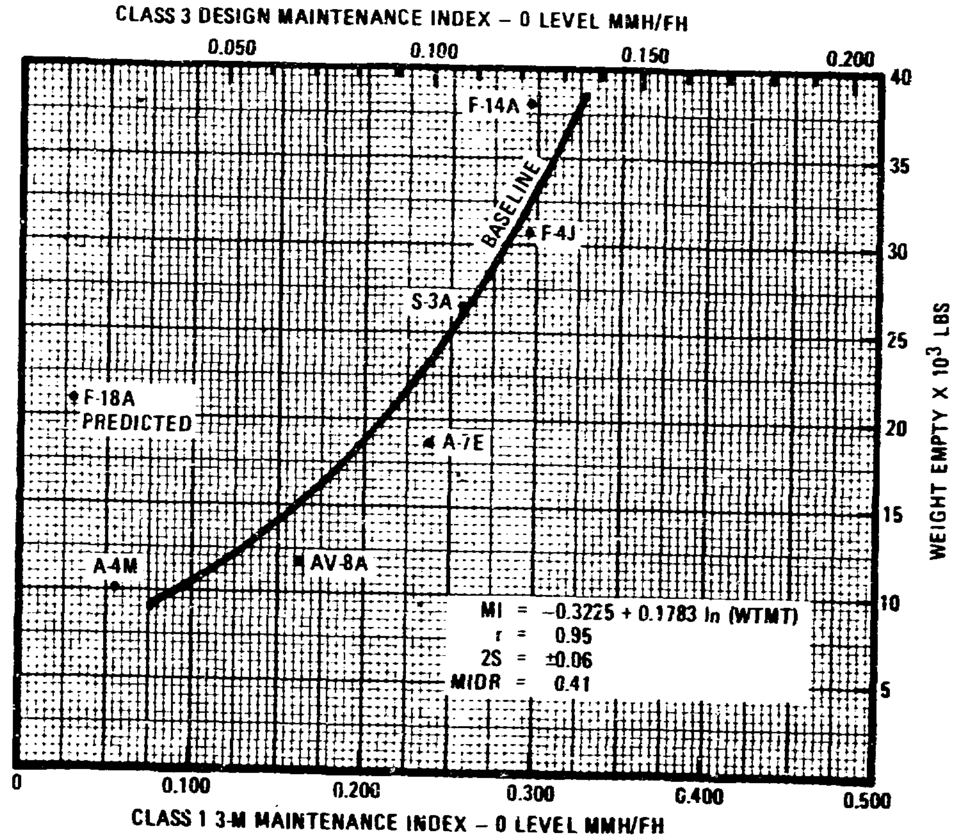


Figure 5.16-1 WUC 57 Maintenance Index Graph

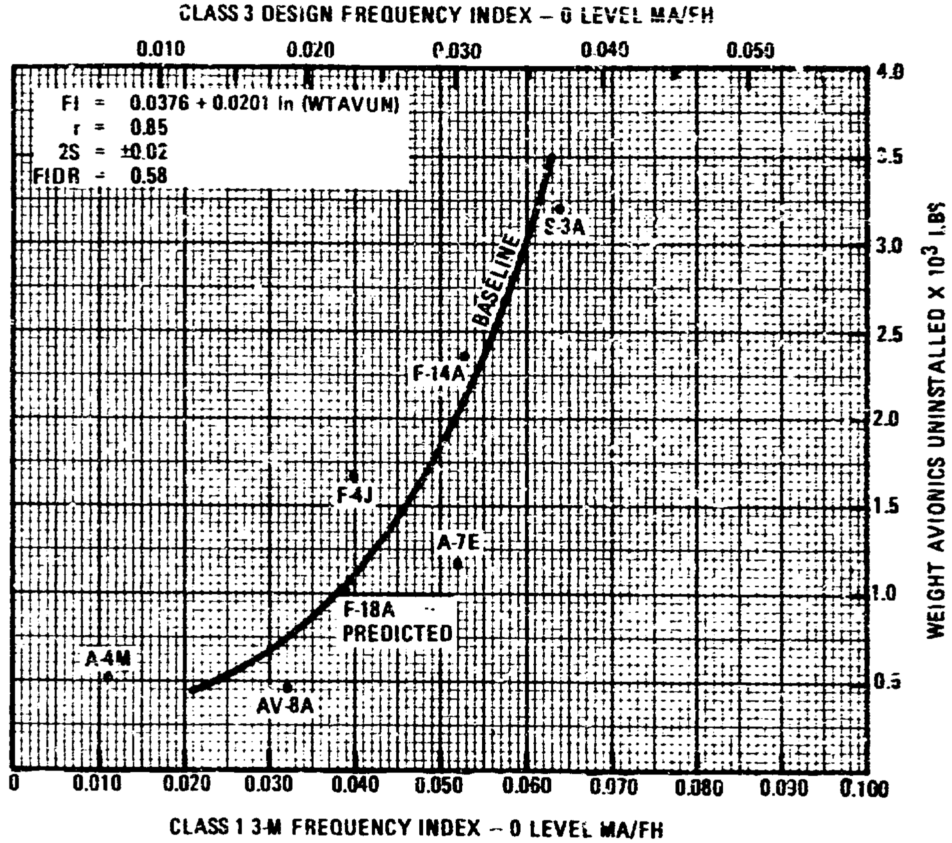


Figure 5.16-2 WUC 57 Frequency Index Graph

WUC. 57 CONTRACTOR:

SYSTEM: Integrated Guidance and Flight Controls AIRCRAFT MODEL:

PART I CONTRACTOR DATA

CONTRACTOR PREDICTIONS – CLASS 3 DESIGN MAINT. REQ.				
ML	MMH/FH	MA/FH	MMH/MA	EMT/MA
O				
I				

DESIGN/PERFORMANCE PARAMETERS	
Weight Empty, lbs.	
Weight Avionics Uninstalled, lbs.	

PART II SYSTEM CONSTANTS

PARAMETER		BASE	PRED
MEN_O	AVG NO. MEN – O LEVEL	2.0	
MEN_I	AVG NO. MEN – I LEVEL	1.4	
MIIR	MMH/FH I LEVEL RATIO	.54	
FIIR	MA/FH I LEVEL RATIO	.33	

PART III SYSTEM ANALYSIS

PARAMETER	CALCULATION	BASELINE CLASS 1 3-M DATA (A)	PREDICTED CLASS 1 3-M DATA (B)	IMPROVEMENT (DEGRADATION) (C) Δ	%
MMH/FH_C (1)	MAINT INDEX GRAPH				
	BASELINE				
	PREDICTED				
MA/FH_O (2)	FREQ. INDEX GRAPH				
	BASELINE				
	PREDICTED				
MMH/MA_O (3)	MMH/FH_O ÷ MA/FH_O				
	÷				
EMT/MA_O (4)	MMH/MA_O ÷ MEN_O				
	÷				
	÷				
MMH/FH_I (5)	MMH/FH_O X MIIR				
	X				
	X				
MA/FH_I (6)	MA/FH_O X FIIR				
	X				
	X				
MMH/MA_I (7)	MMH/FH_I ÷ MA/FH_I				
EMT/MA_I (8)	MMH/MA_I ÷ MEN_I				
	÷				
$MMH/FH_{O,I}$ (9)	MMH/FH_O + MMH/FH_I				

FIGURE 5.16-3 Worksheet for Evaluating System Maintenance Requirements

5.17 COMMUNICATIONS SYSTEM - WUC 60

Selected Parameters: Empty weight and avionics weight installed.

Number of Regression Equations Run: 9

Parameters Considered and Rejected: Combat weight, maximum takeoff weight and avionics weight uninstalled.

Comments: The Standard WUC was inadequate to analyze the subsystems under SWUC 60. Only two aircraft reported VHF (SWUC 62) maintenance and five reported Interphone (SWUC 64) maintenance. The wide range of values reported to CNI (SWUC 67) and Miscellaneous (SWUC 69) could not be identified to specific equipment. To achieve a fair analysis for all aircraft, it was decided to combine all subsystems under SWUC 60.

The F-14A was eliminated due to poor regression correlation. Both MMH/FH and MA/FH reported to SWUC 69 were extremely high due to equipment unique to the F-14A.

TABLE 5.17-1 TWO-DIGIT WUC MAINTENANCE DATA SUMMARY

WUC: 6[illegible] SYSTEM: Communications

ACFT	CLASS 1 MAINTENANCE - 3M										
	O LEVEL					I LEVEL					TOTAL
	MMH/FH	MA/FH	MMH/MA	EMT/MA	MEN	MMH/FH	MA/FH	MMH/MA	EMT/MA	MEN	MMH/FH
A4M	.192	.068	2.82	1.58	1.8	.154	.025	6.16	4.86	1.2	.346
A6E	.379	.162	2.33	1.46	1.6	.453	.062	7.30	5.61	1.3	.832
A7F	.256	.107	2.39	1.32	1.8	.211	.040	5.28	4.33	1.2	.467
AV8A	.234	.082	2.85	1.63	1.7	.163	.023	7.08	5.27	1.3	.397
F4J	.546	.186	2.93	1.78	1.6	.531	.085	6.25	5.29	1.2	1.077
F8J	.269	.109	2.47	2.30	1.1	.195	.046	4.24	3.50	1.2	.464
F14A	.858	.318	2.69	1.30	2.0	.732	.087	8.44	5.93	1.4	1.591
S3A	.513	.199	2.58	1.47	1.7	.478	.048	9.96	5.95	1.7	.991
	CLASS 3 MAINTENANCE - DESIGN EQUIVALENT										
A4M	.080	.039	2.04	1.01	2.0	.095	.019	5.01	4.12	1.2	.175
A6E	.162	.100	1.62	.93	1.7	.277	.049	5.65	4.53	1.2	.439
A7E	.110	.071	1.55	.87	1.8	.132	.030	4.38	3.54	1.2	.242
AV8A	.098	.050	1.96	1.10	1.8	.097	.015	6.47	4.41	1.4	.195
F4J	.255	.115	2.21	1.21	1.8	.327	.065	5.03	4.28	1.2	.582
F8J	.108	.064	1.68	.96	1.7	.118	.031	3.81	3.13	1.2	.226
F14A	.323	.186	1.74	.88	2.0	.430	.063	6.83	4.77	1.4	.754
S3A	.152	.092	1.65	.95	1.7	.280	.038	7.37	4.48	1.6	.432

TABLE 5.17-2 REGRESSION ANALYSIS SUMMARY

WUC: 60 SYSTEM: Communications

MAINTENANCE INDEX ESTIMATION - MMH/FH O LEVEL

ACFT	3M MI		ERROR	WEIGHT EMPTY X 10^3 LBS	WEIGHT AVIONICS INSTALLED X 10^3 LBS (WTAVIN)
	ACTUAL	CALCULATED			
A4M	.192	.180	.012	10.4	.612
A6E	.379	.422	-.043	26.0	2.329
A7E	.256	.302	-.046	18.9	1.347
AV8A	.234	.196	.038	12.0	.590
F4J	.546	.486	.060	30.8	2.641
F8J	.269	.287	-.018	19.8	.819
S3A	.513	.515	-.002	26.6	4.223

STATISTICAL PARAMETERS:

REGRESSION EQUATION	MI =	0.0428 + 0.0104 (WTMT) +0.0460 (WTAVIN)
CORRELATION COEFFICIENT	r =	0.9592
STANDARD ERROR OF ESTIMATE	S =	0.0488
CONFIDENCE LEVEL, 95%	2S =	±0.0976
NUMBER OF OBSERVATIONS	N =	7

FREQUENCY INDEX ESTIMATION - MA/FH O LEVEL

ACFT	3M FI		ERROR	WEIGHT EMPTY X 10^3 LBS (WTMT)	WEIGHT AVIONICS INSTALLED X 10^3 LBS (WTAVIN)
	ACTUAL	CALCULATED			
A4M	.068	.070	-.002	10.4	.612
A6E	.162	.160	.002	26.0	2.329
A7E	.102	.115	-.008	18.9	1.347
AV8A	.082	.075	.007	12.0	.590
F4J	.186	.184	.002	30.8	2.641
F8J	.109	.109	.000	19.8	.819
S3A	.199	.199	.000	26.6	4.223

STATISTICAL PARAMETERS:

REGRESSION EQUATION	FI =	0.0194 + 0.0037 (WTMT) +0.0190 (WTAVIN)
CORRELATION COEFFICIENT	r =	0.9961
STANDARD ERROR OF ESTIMATE	S =	0.0055
CONFIDENCE LEVEL, 95%	2S =	±0.0110
NUMBER OF OBSERVATIONS	N =	7

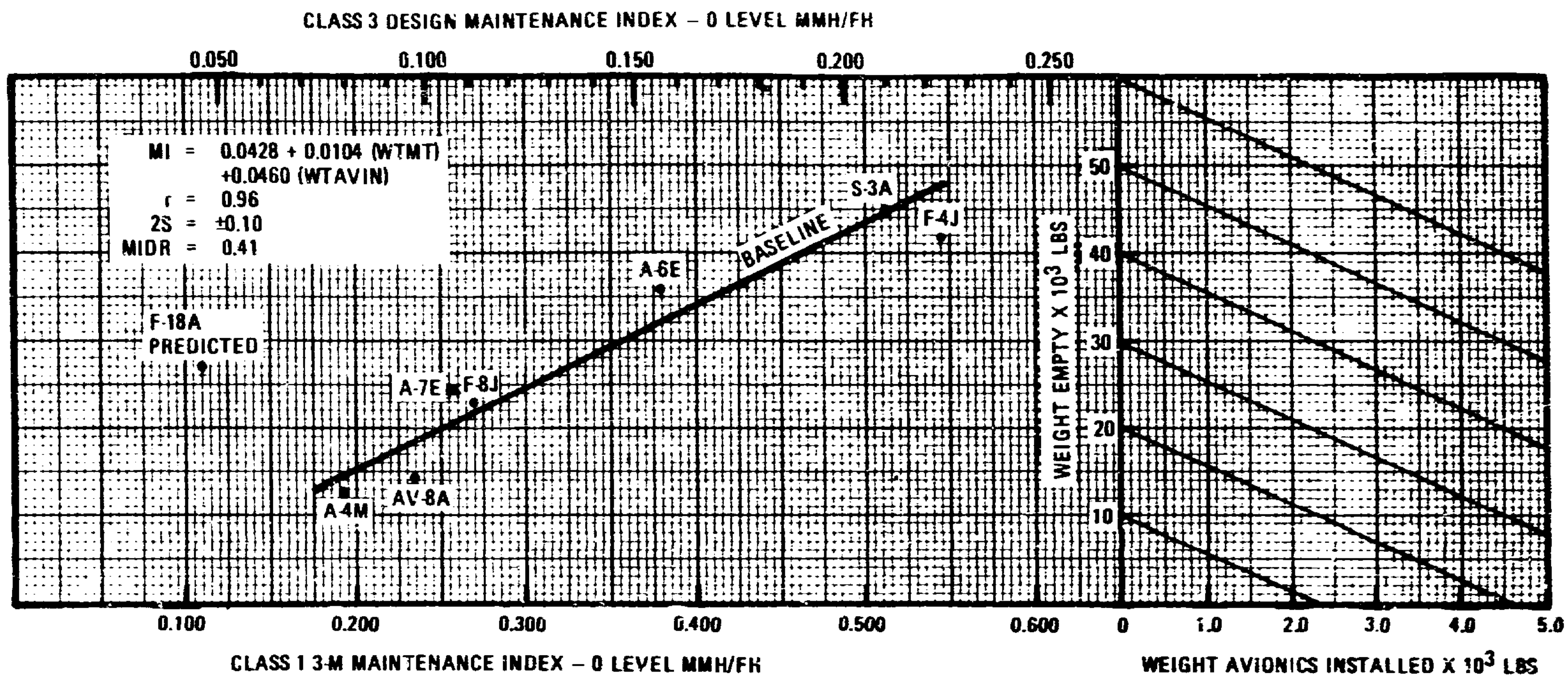


Figure 5.17-1 WUC 60 Maintenance Index Graph

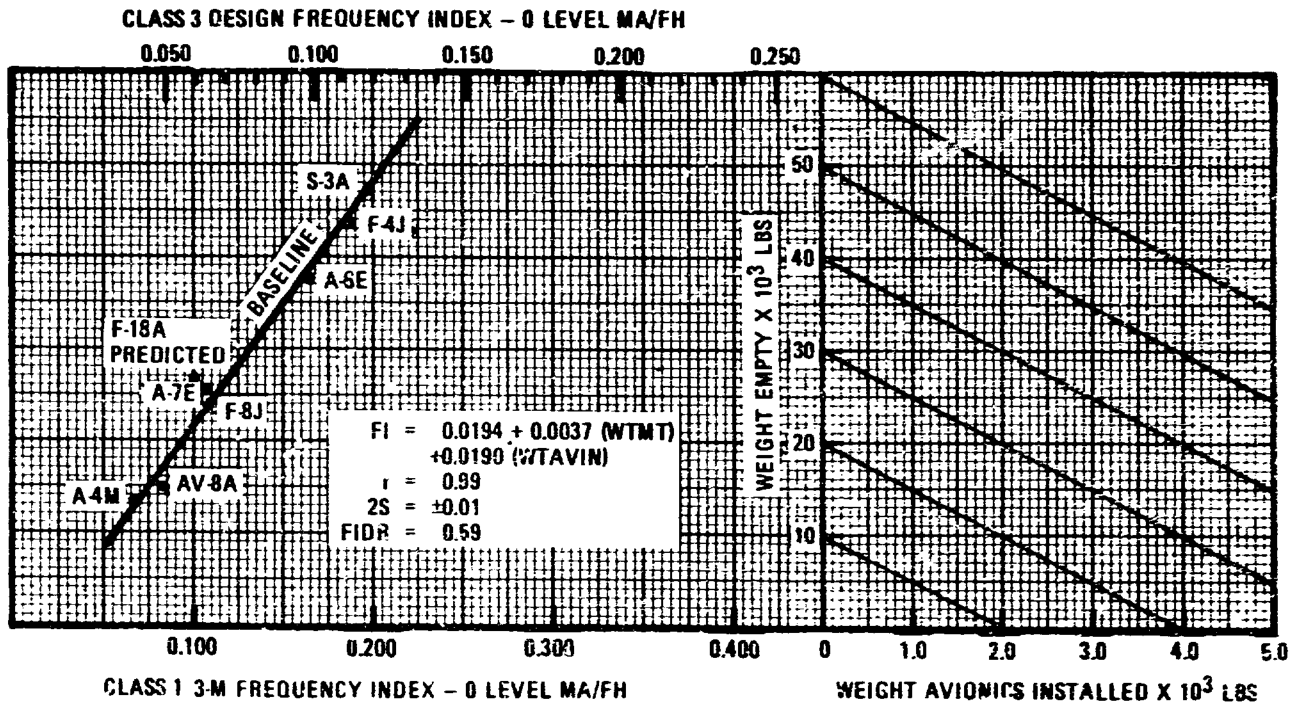


Figure 5.17-2 WUC 60 Frequency Index Graph

WUC: 60 CONTRACTOR: ______
SYSTEM: Communications AIRCRAFT MODE ______

PART I CONTRACTOR DATA

CONTRACTOR PREDICTIONS – CLASS 3 DESIGN MAINT. REQ.				
ML	MMH/FH	MA/FH	MMH/MA	EMT/MA
O				
I				

DESIGN/PERFORMANCE PARAMETERS	
Weight Empty, lbs. Weight Avionics Installed, lbs.	

PART II SYSTEM CONSTANTS

PARAMETER		BASE	PRED
MEN_O	AVG NO. MEN – O LEVEL	1.6	
MEN_I	AVG NO. MEN – I LEVEL	1.3	
MIIR	MMH/FH I LEVEL RATIO	.88	
FIIR	MA/FH I LEVEL RATIO	.36	

PART III SYSTEM ANALYSIS

PARAMETER	CALCULATION	BASELINE CLASS 1 3-M DATA (A)	PREDICTED CLASS 1 3-M DATA (B)	IMPROVEMENT (DEGRADATION) (C) Δ	%
MMH/FH_O (1)	MAINT INDEX GRAPH				
	BASELINE				
	PREDICTED				
MA/FH_O (2)	FREQ. INDEX GRAPH				
	BASELINE				
	PREDICTED				
MMH/MA_O (3)	MMH/FH_O MA/FH_O				
EMT/MA_O (4)	$MMH/MA_O \div MEN_O$				
	÷				
	÷				
MMH/FH_I (5)	MMH/FH_O X MIIR				
	X				
	X				
MA/FH_I (6)	MA/FH_O X FIIR				
	X				
	X				
MMH/MA_I (7)	MMH/FH_I MA/FH_I				
EMT/MA_I (8)	MMH/MA_I MEN_I				
$MMH/FH_{O,I}$ (9)	$MMH/FH_O + MMH/FH_I$				

FIGURE 5.17-3 Worksheet for Evaluating System Maintenance Requirements

5.18 NAVIGATION/WEAPON CONTROL SYSTEM - WUC 71, 72, 73, 74

Selected Parameters: Avionics weight uninstalled

Number of Regression Equations Run: 8

Parameters Considered and Rejected: Empty weight, combat weight, maximum takeoff weight and avionics weight installed.

Comments: The Navigation/Weapon Control system was the largest grouping of SWUC's used in the MIM. These systems were grouped together because the standard WUC's, while an improvement over existing WUC's, were not definitive enough to allow comparison of individual systems in the navigation and weapon control area. For example, Bombing Navigation (SWUC 73) was the high maintenance system for attack/ASW aircraft while Weapon Control (SWUC 74) was the high mainenance system for fighter aircraft. In addition, the maintenance requirements for equipment within a system were primarily a function of equipment design (old/new generation), functional capability and mission requirement.

Excellent correlation was obtained using uninstalled avionics weight. Historical data showed that as aircraft avionics weight increased, so did system maintenance. This trend even held true for the newer generation aircraft (F-14, S-3A) with improved avionics equipment. One reason for this trend was that advances in design technology were offset by the addition of more equipment to the aircraft which had their mission requirements expanded.

The Navigation/Weapon Control system accounted for almost one-fourth of the total unscheduled MMH/FH reported for each aircraft. Approximately one-half of this maintenance was accomplished at O-level and one-half at I-level. At O-level, one-half of all reported maintenance actions were "no defects" (Navy Responsible Actions). At 1-level, one-fourth of the reported maintenance actions were "no defects".

The F-4J was not used in the regression analysis due to poor correlation results. Higher than normal radar maintenance in SWUC 74 would have distorted the analysis.

TABLE 5.18-1 TWO-DIGIT WUC MAINTENANCE DATA SUMMARY

WUC: 71, 72, 73, 74 SYSTEM: Navigation/Weapon Control

ACFT	CLASS 1 MAINTENANCE - 3M										
	O LEVEL					I LEVEL					TOTAL
	MMH/FH	MA/FH	MMH/MA	EMT/MA	MEN	MMH/FH	MA/FH	MMH/MA	EMT/MA	MEN	MMH/FH
A4M	.597	.146	4.09	2.15	1.9	.329	.063	5.22	3.91	1.3	.926
A6E	2.049	.530	3.86	1.96	2.0	2.369	.221	10.72	7.05	1.5	4.419
A7E	1.515	.404	3.75	1.87	2.0	1.322	.184	7.18	5.01	1.4	2.837
AV8A	.778	.203	3.83	2.00	1.9	.557	.068	8.19	4.60	1.8	1.335
F4J	3.426	.634	5.40	2.63	2.0	2.214	.352	6.29	4.33	1.4	5.640
F8J	1.081	.314	3.44	1.72	2.0	1.168	.186	6.28	4.52	1.4	2.249
F14A	2.202	.561	3.92	1.66	2.4	2.800	.249	11.24	6.91	1.6	5.002
S3A	2.220	.636	3.49	1.90	1.8	2.036	.203	10.03	5.92	1.7	4.256
	CLASS 3 MAINTENANCE - DESIGN EQUIVALENT										
A4M	.228	.079	2.88	1.47	1.9	.186	.039	4.77	3.67	1.3	.414
A6E	.768	.284	2.70	1.33	2.0	1.393	.167	8.34	5.68	1.4	2.161
A7E	.616	.236	2.61	1.28	2.0	.761	.139	5.47	3.94	1.4	1.377
AV8A	.312	.117	2.66	1.36	1.9	.240	.042	5.71	3.87	1.5	.552
F4J	1.574	.430	3.66	1.71	2.1	1.320	.264	5.00	3.54	1.4	2.894
F8J	.468	.199	2.35	1.15	2.0	.691	.122	5.66	4.41	1.3	1.159
F14A	.715	.250	2.86	1.20	2.4	1.497	.156	9.60	6.12	1.5	2.212
S3A	.722	.291	2.48	1.30	1.9	1.202	.168	7.15	4.35	1.6	1.924

TABLE 5.18-2 REGRESSION ANALYSIS SUMMARY

WUC: 71, 72, 73, 74 SYSTEM: Navigation/Weapon Control

MAINTENANCE INDEX ESTIMATION - MMH/FH O LEVEL

ACFT	3M MI		ERROR	WEIGHT AVIONICS UNINSTALLED X 10^3 LBS	
	ACTUAL	CALCULATED			
A4M	.597	.779	-.182	.517	
A6E	2.049	1.922	.126	1.920	
A7E	1.515	1.502	.013	1.185	
AV8A	.778	.677	.101	.460	
F8J	1.081	1.057	.024	.711	
F14A	2.202	2.125	.077	2.422	
S3A	2.220	2.378	-.158	3.240	

STATISTICAL PARAMETERS:

REGRESSION EQUATION $MI = 1.3541 + 0.8715 \ln (WTAVUN)$

CORRELATION COEFFICIENT $r = 0.9837$
STANDARD ERROR OF ESTIMATE $S = 0.1349$
CONFIDENCE LEVEL, 95% $2S = \pm 0.2698$
NUMBER OF OBSERVATIONS $N = 7$

FREQUENCY INDEX ESTIMATION - MA/FH O LEVEL

ACFT	3M FI		ERROR	WEIGHT AVIONICS UNINSTALLED X 10^3 LBS (WTAVUN)	
	ACTUAL	CALCULATED			
A4M	.146	.204	-.058	.517	
A6E	.530	.517	.013	1.920	
A7E	.404	.402	.002	1.185	
AV8A	.203	.177	.026	.460	
F8J	.314	.280	.034	.711	
F14A	.561	.572	-.011	2.422	
S3A	.636	.641	-.005	3.240	

STATISTICAL PARAMETERS:

REGRESSION EQUATION $FI = 0.3616 + 0.2379 \ln (WTAVUN)$

CORRELATION COEFFICIENT $r = 0.9866$
STANDARD ERROR OF ESTIMATE $S = 0.0334$
CONFIDENCE LEVEL, 95% $2S = \pm 0.0668$
NUMBER OF OBSERVATIONS $N = 7$

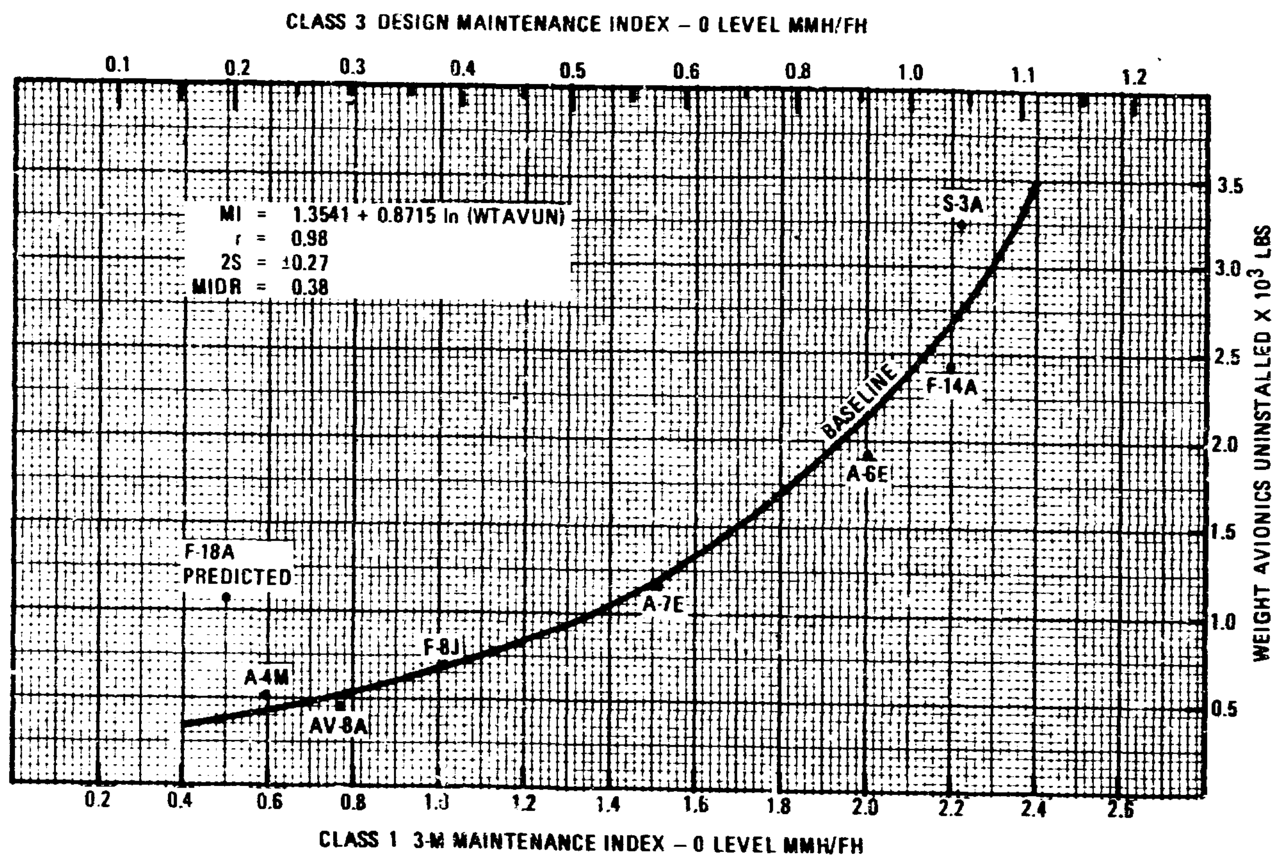


Figure 5.18-1 WUC 71, 72, 73, 74 Maintenance Index Graph

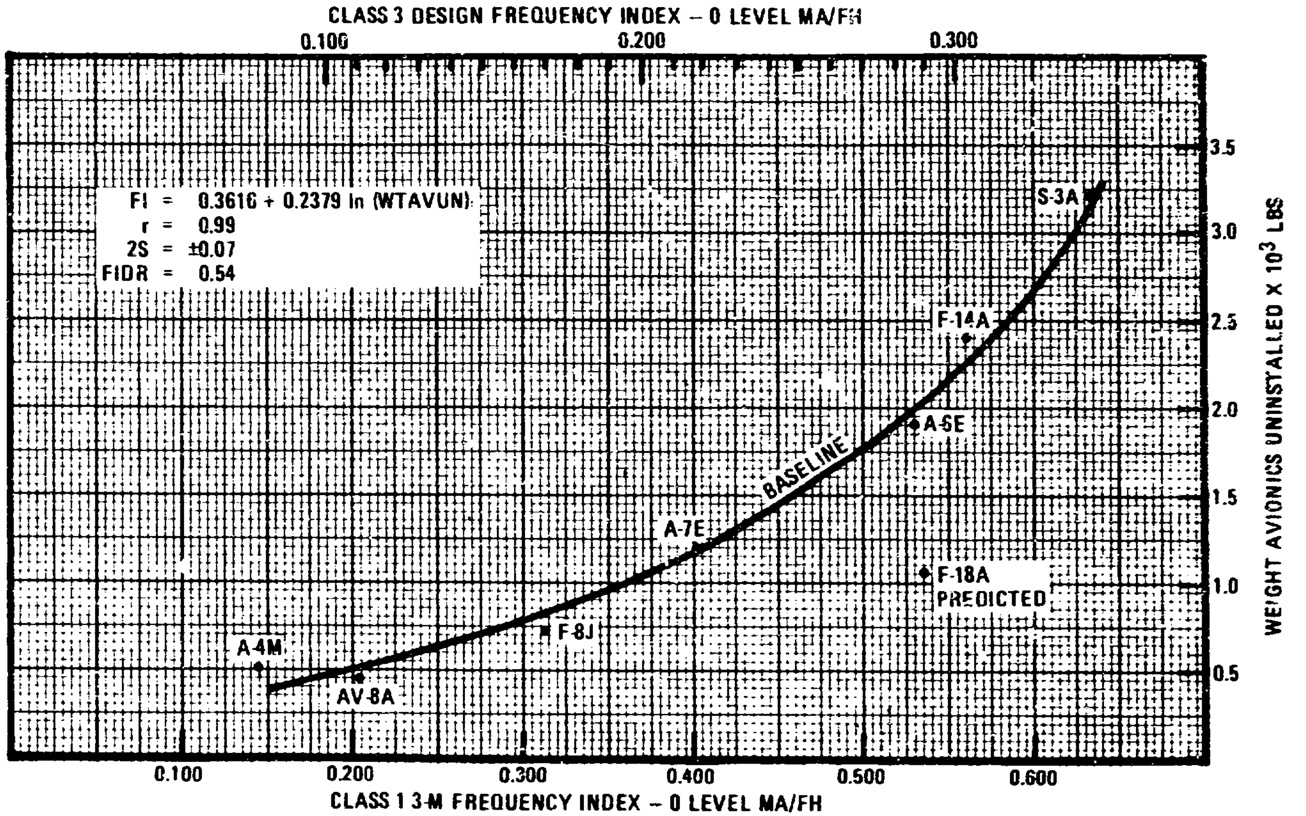


Figure 5.18-2 WUC 71, 72, 73, 74 Frequency Index Graph

WUC: 71, 72, 73, 74 CONTRACTOR: ____

SYSTEM: Navigation/Weapon Control AIRCRAFT MODEL: ____

PART I CONTRACTOR DATA

CONTRACTOR PREDICTIONS – CLASS 3 DESIGN MAINT. REQ.				
ML	MMH/FH	MA/FH	MMH/MA	EMT/MA
O				
I				

DESIGN/PERFORMANCE PARAMETERS	
Weight Avionics Uninstalled, lbs.	

PART II SYSTEM CONSTANTS

PARAMETER		BASE	PRED
MEN_O	AVG NO. MEN – O LEVEL	2.0	
MEN_I	AVG NO. MEN – I LEVEL	1.6	
MIIR	MMH/FH I LEVEL RATIO	.94	
FIIR	MA/FH I LEVEL RATIO	.43	

PART III SYSTEM ANALYSIS

PARAMETER	CALCULATION	BASELINE CLASS 1 3-M DATA (A)	PREDICTED CLASS 1 3-M DATA (B)	IMPROVEMENT (DEGRADATION) (C) Δ	%
MMH/FH_O (1)	MAINT. INDEX GRAPH				
	BASELINE				
	PREDICTED				
MA/FH_O (2)	FREQ. INDEX GRAPH				
	BASELINE				
	PREDICTED				
MMH/MA_O (3)	$MMH/FH_O \div MA/FH_O$				
	÷				
EMT/MA_O (4)	$MMH/MA_O \div MEN_O$				
	÷				
	÷				
MMH/FH_I (5)	MMH/FH_O X MIIR				
	X				
	X				
MA/FH_I (6)	MA/FH_O X FIIR				
	X				
	X				
MMH/MA_I (7)	$MMH/FH_I \div MA/FH_I$				
	÷				
	÷				
EMT/MA_I (8)	$MMH/MA_I \div MEN_I$				
	÷				
	÷				
$MMH/FH_{O,I}$ (9)	$MMH/FH_O + MMH/FH_I$				

FIGURE 5.18-3 Worksheet for Evaluating System Maintenance Requirements

5.19 WEAPON DELIVERY SYSTEM - WUC 75

Selected Parameters. Empty weight and number of pylons. Index constants were established for gun maintenance.

Number of Regression Equations Run: 14

Parameters Considered and Rejected: Maximum takeoff weight, gun weight and useful load weight.

Comments: Weapon Delivery system maintenance was found to be a function of empty weight, number of pylons and whether an aircraft had a gun subsystem. Since three aircraft did not have guns, the regression analysis was conducted with gun MMH/FH and MA/FH deleted. Index constants of 0.082 MMH/FH and 0.017 MA/FH were established for aircraft with a gun subsystem by averaging gun maintenance data:

AIRCRAFT	MMH/FH	MA/FH
A-4M	.074	.019
A-7E	.083	.019
AV-8A	.055	.008
F-8J	.106	.026
F-14A	.094	.012
TOTAL	.412	.084

Gun MMH/FH index constant: .412 ÷ 5 = .082
Gun MMH/FH index constant: .084 ÷ 5 = .017

Results are displayed graphically in Figures 5.19-1 and 5.19-2 for aircraft with and without a gun subsystem.

The F-14A was eliminated from the Maintenance Index analysis due to poor regression correlation. Actual MMH/FH without the gun ran 2.4 times greater than the calculated value. The F-14A required much higher than normal maintenance to launchers/racks and pylons. The A-4M, A-7E and F-14A were eliminated from the Frequency Index analysis due to poor regression analysis. Actual MA/FH ran from 2 to 2.5 times greater than calculated values.

TABLE 5.19-1 TWO-DIGIT WUC MAINTENANCE DATA SUMMARY

WUC: 75 SYSTEM: Weapon Delivery

ACFT	CLASS 1 MAINTENANCE - 3M										
	O LEVEL					I LEVEL					TOTAL
	MMH/FH	MA/FH	MMH/MA	EMT/MA	MEN	MMH/FH	MA/FH	MMH/MA	EMT/MA	MEN	MMH/FH
A4M	.166	.052	3.18	1.79	1.8	.175	.013	12.75	8.15	1.6	.341
A6E	.082	.029	2.85	1.39	1.8	.031	.009	3.57	3.00	1.2	.113
A7E	.273	.075	3.67	1.85	2.0	.175	.036	4.84	4.23	1.1	.448
AV8A	.139	.025	5.59	2.35	2.4	.023	.007	3.10	1.28	2.4	.162
F4J	.331	.038	8.78	4.19	2.0	.085	.018	4.76	3.18	1.5	.416
F8J	.153	.037	4.07	1.76	2.3	.045	.040	1.12	.67	1.7	.198
F14A	.605	.102	5.93	2.09	2.8	.083	.017	4.91	2.66	1.8	.688
S3A	.053	.013	3.97	2.01	2.0	.004	.002	2.25	2.10	1.1	.057
	CLASS 3 MAINTENANCE - DESIGN EQUIVALENT										
A4M	.077	.032	2.42	1.30	1.8	.102	.012	8.48	5.53	1.5	.179
A6E	.037	.018	2.04	.99	2.0	.020	.008	2.45	2.05	1.2	.056
A7E	.128	.056	2.29	1.16	2.0	.107	.030	3.57	3.16	1.1	.235
AV8A	.073	.018	4.07	1.68	2.6	.006	.003	1.98	1.16	1.7	.079
F4J	.172	.023	7.46	3.29	2.2	.044	.014	3.12	2.17	1.4	.215
F8J	.081	.028	2.89	1.25	2.3	.038	.038	1.00	.60	1.6	.119
F14A	.115	.037	3.10	1.22	2.5	.035	.010	3.48	2.30	1.5	.150
S3A	.020	.010	2.01	1.09	1.8	.002	.001	1.83	1.67	1.1	.022

TABLE 5.19-2 REGRESSION ANALYSIS SUMMARY

WUC: 75 SYSTEM: Weapon Delivery

MAINTENANCE INDEX ESTIMATION - MMH/FH O LEVEL

ACFT	3M MI		ERROR	Weight Empty X 10^3 Lbs (WTMT)	Number of Pylons (PYLQTY)
	ACTUAL	CALCULATED			
A4M	.092 *	.069	.023	10.4	5.0
A6E	.082	.131	-.049	26.0	5.0
A7E	.190 *	.213	-.023	18.9	8.0
AV8A	.084 *	.075	.009	12.0	5.0
F4J	.331	.297	.034	30.8	9.0
F8J	.047 *	.070	-.023	19.8	4.0
S3A	.053	.024	.029	26.6	2.0

STATISTICAL PARAMETERS:

REGRESSION EQUATION	MI =	-0.1563 + 0.0040 (WTMT) +0.0367 (PLYQTY)
CORRELATION COEFFICIENT	r =	0.9501
STANDARD ERROR OF ESTIMATE	S =	0.0390
CONFIDENCE LEVEL, 95%	2S =	±0.0780
NUMBER OF OBSERVATIONS	N =	7

FREQUENCY INDEX ESTIMATION - MA/FH O LEVEL

ACFT	3M FI		ERROR	Weight Empty X 10^3 Lbs (WTMT)	Number of Pylons (PYLQTY)
	ACTUAL	CALCULATED			
A6E	.029	.023	.006	26.0	5.0
AV8A	.017 *	.015	.002	12.0	5.0
F4J	.038	.040	-.002	30.8	9.0
F8J	.011 *	.016	-.005	19.8	4.0
S3A	.013	.013	.000	26.6	2.0

STATISTICAL PARAMETERS:

REGRESSION EQUATION	FI =	-0.0087 + 0.0006 (WTMT) +0.0034 (PLYQTY)
CORRELATION COEFFICIENT	r =	0.9348
STANDARD ERROR OF ESTIMATE	S =	0.0058
CONFIDENCE LEVEL, 95%	2S =	±0.0116
NUMBER OF OBSERVATIONS	N =	5

* Gun Data Excluded

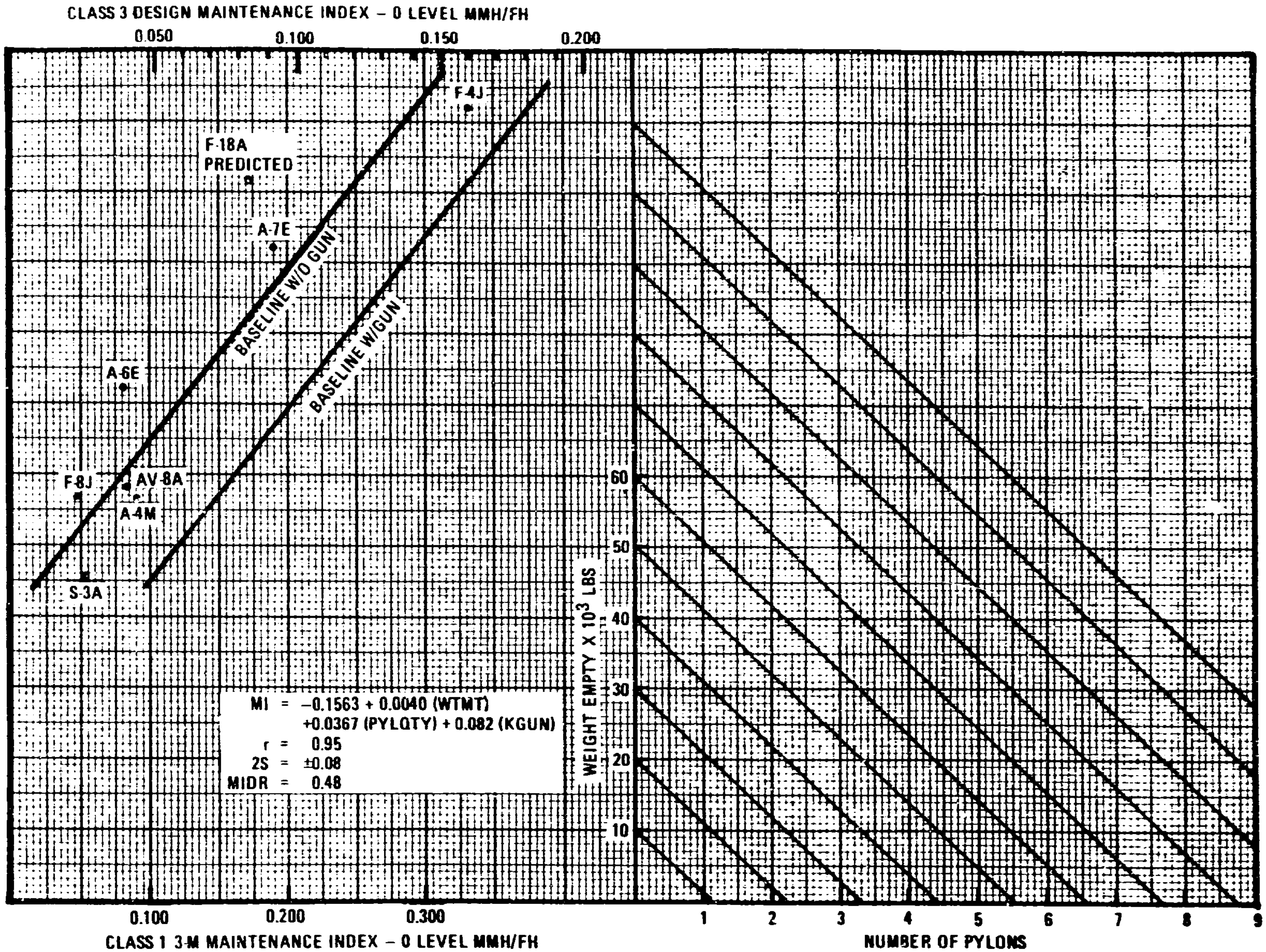


Figure 5.19-1 WUC 75 Maintenance Index Graph

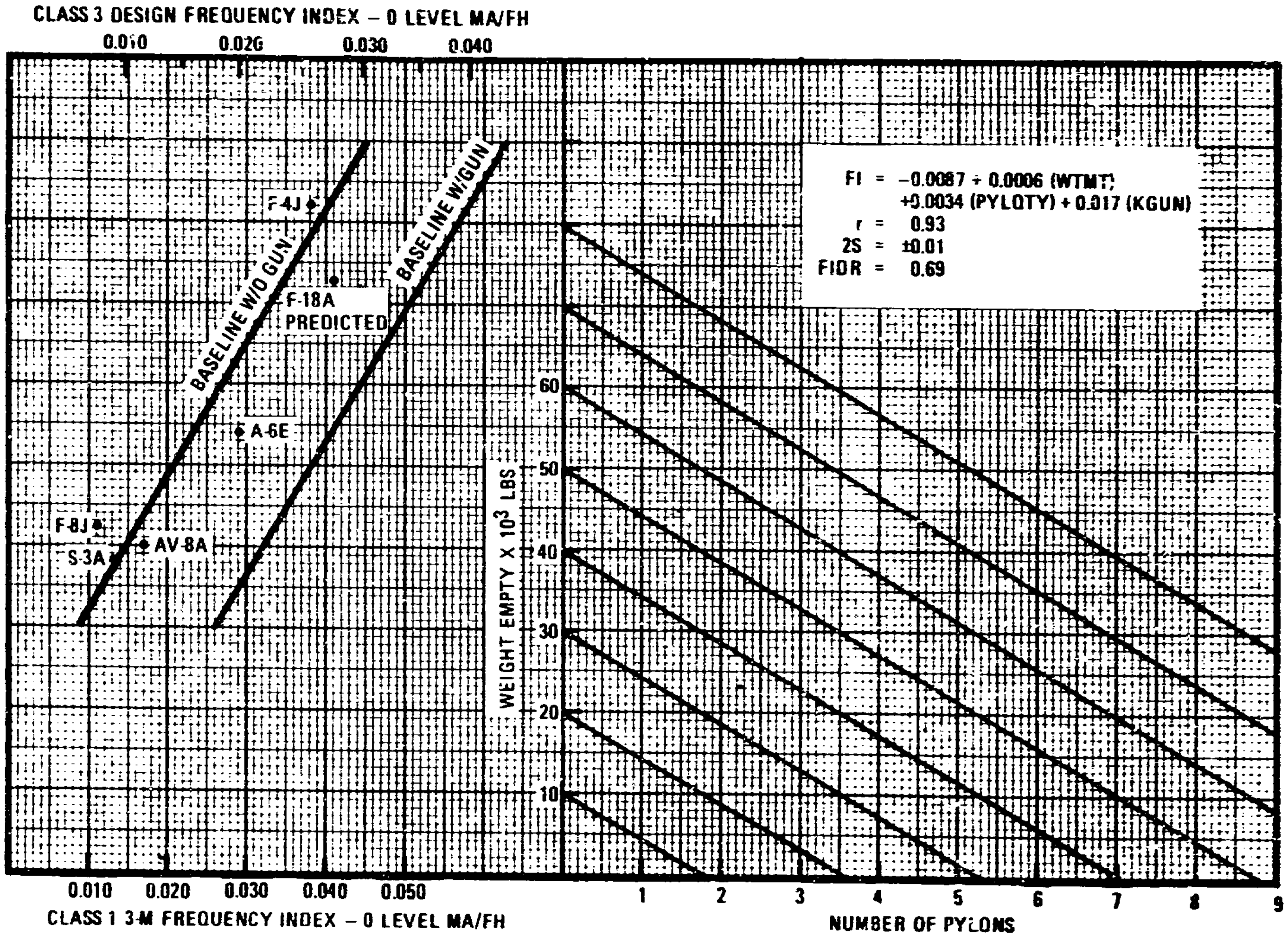


Figure 5.19-2 WUC 75 Frequency Index Graph

WUC: 75 CONTRACTOR: ____
SYSTEM: Weapon Delivery AIRCRAFT MODEL: ____

PART I CONTRACTOR DATA

CONTRACTOR PREDICTIONS – CLASS 3 DESIGN MAINT. REQ.				
ML	MMH/FH	MA/FH	MMH/MA	EMT/MA
O				
I				

DESIGN/PERFORMANCE PARAMETERS	
Weight Empty, lbs. Number of Pylons Gun Factor, 1 or 0	

PART II SYSTEM CONSTANTS

PARAMETER		BASE	PRED
MEN_O	AVG NO. MEN – O LEVEL	2.0	
MEN_I	AVG NO. MEN – I LEVEL	1.5	
MIIR	MMH/FH I LEVEL RATIO	.50	
FIIR	MA/FH I LEVEL RATIO	.46	

PART III SYSTEM ANALYSIS

PARAMETER	CALCULATION	BASELINE CLASS 1 3-M DATA (A)	PREDICTED CLASS 1 3-M DATA (B)	IMPROVEMENT (DEGRADATION) (C) Δ	%
MMH/FH_O (1)	MAINT. INDEX GRAPH				
	BASELINE				
	PREDICTED				
MA/FH_O (2)	FREQ. INDEX GRAPH				
	BASELINE				
	PREDICTED				
MMH/MA_O (3)	$MMH/FH_O \div MA/FH_O$				
	÷				
	÷				
EMT/MA_O (4)	$MMH/MA_O \div MEN_O$				
	÷				
	÷				
MMH/FH_I (5)	$MMH/FH_O \times MIIR$				
	X				
	X				
MA/FH_I (6)	$MA/FH_O \times FIIR$				
	X				
	X				
MMH/MA_I (7)	$MMH/FH_I \div MA/FH_I$				
	÷				
	÷				
EMT/MA_I (8)	$MMH/MA_I \div MEN_I$				
	÷				
	÷				
$MMH/FH_{O,I}$ (9)	$MMH/FH_O + MMH/FH_I$				

FIGURE 5.19-3 Worksheet for Evaluating System Maintenance Requirements

5.20 ELECTRONIC COUNTERMEASURES SYSTEM - WUC 76

Selected Parameters: Empty weight.

Number of Regression Equations Run: 5

Parameters Considered and Rejected: Maximum takeoff weight, avionics weight installed and avionics weight uninstalled.

Comments: ECM maintenance was found to be a function of empty weight. Fighter aircraft with their more hostile mission requirement required more ECM maintenance than the attack aircraft.

Aircraft eliminated from the regression analysis were the F-8J, S-3A and AV-8A. The F-8J had very high ECM maintenance caused by two radar sets.

The S-3A exhibited low maintenance since it had minimal equipment. The AV-8A did not have ECM equipment.

TABLE 5.20-1 TWO-DIGIT WUC MAINTENANCE DATA SUMMARY

WUC: 76 SYSTEM: Electronics Countermeasures

ACFT	CLASS 1 MAINTENANCE - 3M										
	O LEVEL					I LEVEL					TOTAL
	MMH/FH	MA/FH	MMH/MA	EMT/MA	MEN	MMH/FH	MA/FH	MMH/MA	EMT/MA	MEN	MMH/FH
A4M	.062	.012	5.08	2.36	2.1	.040	.004	8.94	7.85	1.1	.102
A6E	.180	.034	5.23	2.66	1.9	.142	.013	10.70	7.07	1.5	.322
A7E	.125	.032	3.87	2.06	1.9	.136	.012	11.32	7.57	1.5	.261
AV8A	-	-	-	-	-	-	-	-	-	-	-
F4J	.249	.039	6.36	3.17	2.0	.128	.011	11.46	7.11	1.6	.377
F8J	.352	.067	5.26	2.61	2.0	.413	.046	8.92	7.11	1.2	.765
F14A	.355	.064	5.48	2.34	2.3	.397	.023	16.83	10.31	1.6	.752
S3A	.089	.021	4.14	2.12	1.9	.033	.005	6.62	3.35	2.0	.122
	CLASS 3 MAINTENANCE - DESIGN EQUIVALENT										
A4M	.028	.007	3.97	1.73	2.3	.024	.004	5.99	5.40	1.1	.052
A6E	.071	.022	3.20	1.54	2.0	.088	.011	7.96	5.47	1.4	.158
A7E	.053	.021	2.51	1.27	2.0	.085	.010	8.53	5.87	1.4	.138
AV8A	-	-	-	-	-	-	-	-	-	-	-
F4J	.085	.020	4.25	2.09	2.0	.072	.008	8.95	5.70	1.6	.157
F8J	.161	.049	3.28	1.56	2.1	.253	.037	6.84	5.61	1.2	.414
F14A	.120	.039	3.06	1.32	2.3	.240	.017	14.12	9.06	1.5	.360
S3A	.027	.009	3.02	1.51	2.0	.022	.005	4.31	2.30	1.9	.049

TABLE 5.20-2 REGRESSION ANALYSIS SUMMARY

WUC: 76 SYSTEM: ECM

MAINTENANCE INDEX ESTIMATION - MMH/FH O LEVEL

ACFT	3M MI		ERROR	WEIGHT EMPTY X 10^3 LBS (WTMT)	
	ACTUAL	CALCULATED			
A4M	.062	.044	.018	10.4	
A6E	.180	.206	-.026	26.0	
A7E	.125	.132	-.007	18.9	
F4J	.249	.256	-.007	30.8	
F14A	.355	.333	.022	38.2	

STATISTICAL PARAMETERS:

REGRESSION EQUATION	MI =	-0.0645 + 0.0104 (WTMT)
CORRELATION COEFFICIENT	r =	0.9843
STANDARD ERROR OF ESTIMATE	S =	0.0231
CONFIDENCE LEVEL, 95%	2S =	±0.0462
NUMBER OF OBSERVATIONS	N =	5

FREQUENCY INDEX ESTIMATION - MA/FH O LEVEL

ACFT	3M FI		ERROR	WEIGHT EMPTY X 10^3 LBS (WTMT)	
	ACTUAL	CALCULATED			
A4M	.0120	.0123	-.0003	10.4	
A6E	.0340	.0381	-.0041	26.0	
A7E	.0320	.0263	.0057	18.9	
F4J	.0390	.0460	-.0070	30.8	
F14A	.0640	.0583	.0057	38.2	

STATISTICAL PARAMETERS:

REGRESSION EQUATION	FI =	-0.0049 + 0.0016 (WTMT)
CORRELATION COEFFICIENT	r =	0.9516
STANDARD ERROR OF ESTIMATE	S =	0.0066
CONFIDENCE LEVEL, 95%	2S =	±0.0132
NUMBER OF OBSERVATIONS	N =	5

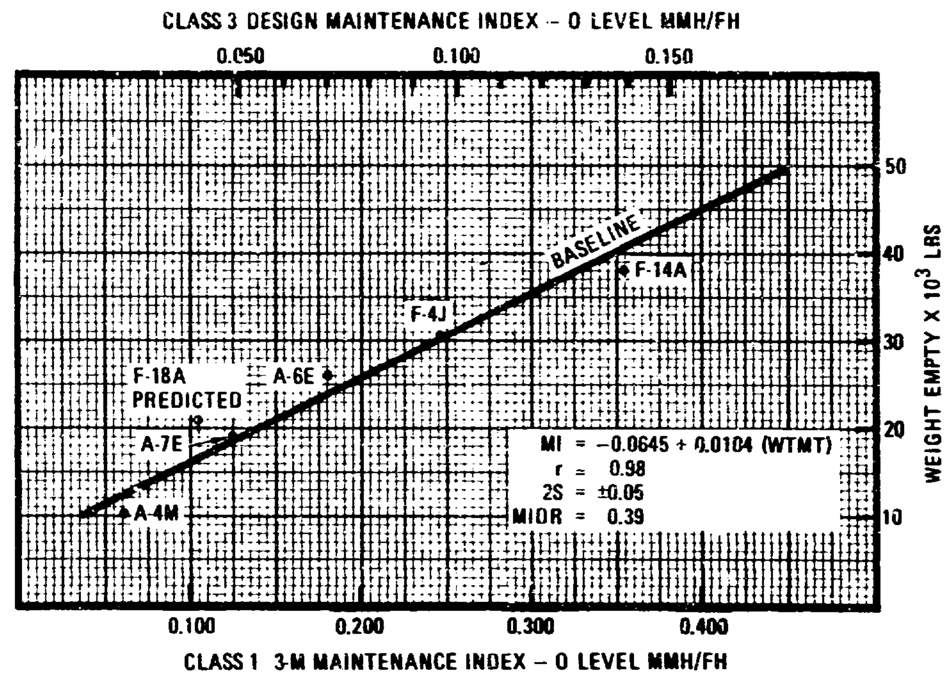


Figure 5.20-1 WUC 76 Maintenance Index Graph

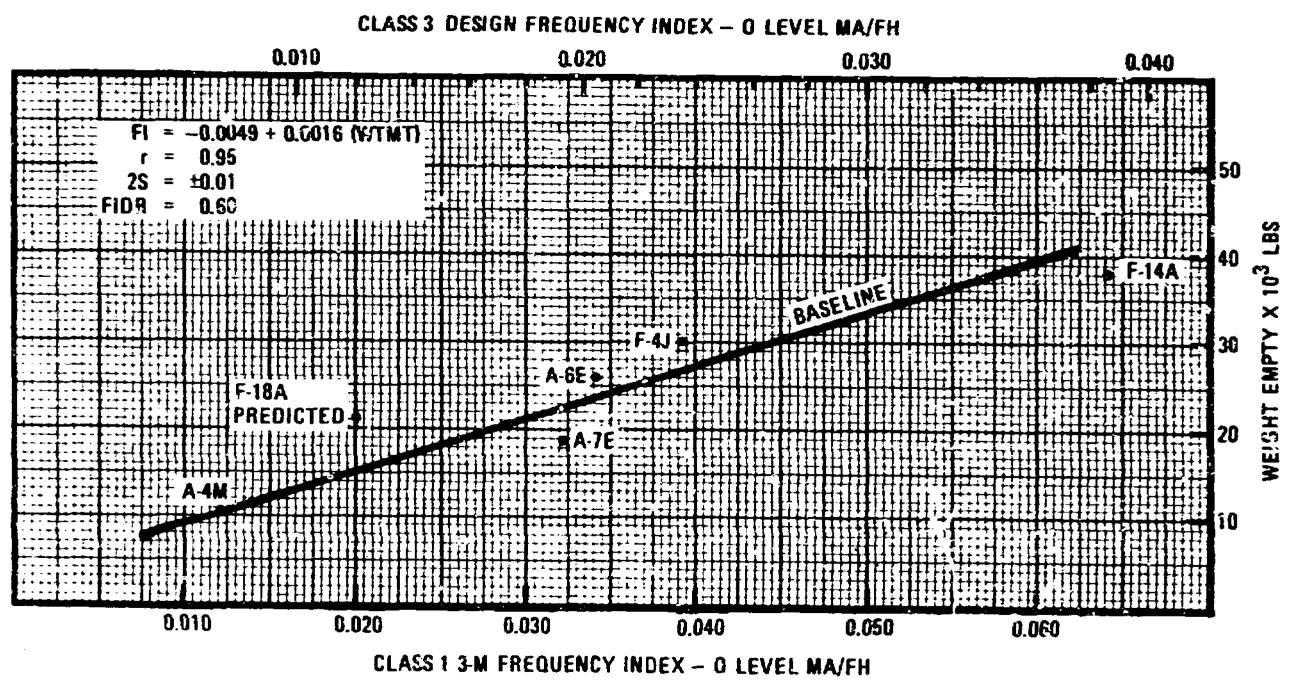


Figure 5.20-2 WUC 76 Frequency Index Graph

WUC: 76 CONTRACTOR: ______

SYSTEM: Electronic Countermeasures AIRCRAFT MODEL: ______

PART I CONTRACTOR DATA

CONTRACTOR PREDICTIONS – CLASS 3 DESIGN MAINT. REQ.				
ML	MMH/FH	MA/FH	MMH/MA	EMT/MA
O				
I				

DESIGN/PERFORMANCE PARAMETERS	
Weight Empty, lbs.	

PART II SYSTEM CONSTANTS

PARAMETER		BASE	PRED
MEN_O	AVG NO. MEN – O LEVEL	2.0	
MEN_I	AVG NO. MEN – I LEVEL	1.5	
MIIR	MMH/FH I LEVEL RATIO	.83	
FIIR	MA/FH I LEVEL RATIO	.35	

PART III SYSTEM ANALYSIS

PARAMETER	CALCULATION	BASELINE CLASS 1 3-M DATA (A)	PREDICTED CLASS 1 3-M DATA (B)	IMPROVEMENT (DEGRADATION) (C) Δ	%
MMH/FH_O (1)	MAINT. INDEX GRAPH				
	BASELINE				
	PREDICTED				
MA/FH_O (2)	FREQ. INDEX GRAPH				
	BASELINE				
	PREDICTED				
MMH/MA_O (3)	$MMH/FH_O \div MA/FH_O$				
	÷				
	÷				
EMT/MA_O (4)	$MMH/MA_O \div MEN_O$				
	÷				
	÷				
MMH/FH_I (5)	MMH/FH_O X MIIR				
	X				
	X				
MA/FH_I (6)	MA/FH_O X FIIR				
	X				
	X				
MMH/MA_I (7)	$MMH/FH_I \div MA/FH_I$				
	÷				
	÷				
EMT/MA_I (8)	$MMH/MA_I \div MEN_I$				
	÷				
	÷				
$MMH/FH_{O,I}$ (9)	$MMH/FH_O + MMH/FH_I$				

FIGURE 5.20-3 Worksheet for Evaluating System Maintenance Requirements

5.21 MISCELLANEOUS EQUIPMENTS - WUC 90

Selected Parameters: Maximum takeoff weight and crew size. Index constants were established for drag chute.

Number of Regression Equations Run: 6

Parameters Considered and Rejected: Empty weight.

Comments: Miscellaneous Equipments comprise such subsystems as emergency/personnel equipment, explosive devices and drag chutes. System maintenance was found to be a function of maximum takeoff weight, crew size and whether an aircraft had a drag chute. Since only two aircraft had drag chutes, the regression analysis was conducted with drag chute MMH/FH and MA/FH deleted. Index constants of 0.014 MMH/FH and 0.007 MA/FH were established as follows:

AIRCRAFT	MMH/FH	MA/FH
A-4M	.017	011
F-4J	.011	004
TOTAL	.028	015

Drag chute MMH/FH index constant .028 ÷ 2 = .014
Drag chute MA/FH index constant .015 ÷ 2 = .007

These constants should be added to the regression equation total for those aircraft requiring drag chutes.

The F-4J was eliminated from the regression analysis due to very high maintenance for explosive devices.

TABLE 5.21-1 TWO-DIGIT WUC MAINTENANCE DATA SUMMARY

WUC: 99 SYSTEM: Miscellaneous Equipment

ACFT	CLASS 1 MAINTENANCE - 3M										
	O LEVEL					I LEVEL					TOTAL
	MMH/FH	MA/FH	MMH/MA	EMT/MA	MEN	MMH/FH	MA/FH	MMH/MA	EMT/MA	MEN	MMH/FH
A4M	.063	.027	2.33	1.44	1.6	.017	.002	8.50	5.10	1.6	.080
A6E	.030	.012	2.50	1.65	1.5	.012	.002	5.19	4.21	1.2	.042
A7E	.033	.014	2.26	1.71	1.3	.002	.001	2.44	2.27	1.1	.035
AV8A	.046	.007	6.67	3.60	1.8	.002	-	6.50	6.50	1.0	.048
F4J	.120	.024	5.00	1.53	3.2	.017	.006	2.83	2.43	1.1	.137
F8J	.030	.008	3.75	2.62	1.4	.007	.004	1.75	1.52	1.1	.037
F14A	.045	.029	1.55	1.11	1.4	.010	.004	2.52	2.52	1.0	.055
S3A	.161	.084	1.91	1.30	1.4	.006	.003	1.64	1.45	1.0	.167
	CLASS 3 MAINTENANCE - DESIGN EQUIVALENT										
A4M	.031	.015	2.05	1.08	1.9	.008	.002	4.08	3.32	1.2	.039
A6E	.014	.007	2.01	1.68	1.2	.006	.002	2.99	2.48	1.2	.020
A7E	.019	.012	1.56	1.13	1.4	.002	.001	2.13	1.93	1.1	.021
AV8A	.025	.006	4.18	2.13	1.9	-	-	-	-	-	.025
F4J	.069	.020	3.44	2.45	1.4	.011	.005	2.29	1.72	1.3	.080
F8J	.014	.007	1.93	1.47	1.3	.006	.004	1.39	1.08	1.3	.019
F14A	.020	.017	1.18	.79	1.5	.008	.004	1.39	1.82	1.0	.028
S3A	.066	.046	1.44	.88	1.6	.004	.003	1.36	1.13	1.2	.070

TABLE 5.21.2 REGRESSION ANALYSIS SUMMARY

WUC: 90 SYSTEM: Miscellaneous Equipment

MAINTENANCE INDEX ESTIMATION - MMH/FH O LEVEL

ACFT	3M MI		ERROR	WEIGHT MAXIMUM TAKEOFF X 10^3 LBS (WTMXTO)	CREW SIZE (CREW)
	ACTUAL	CALCULATED			
A4M	.046 *	.046	.000	24.5	1.0
A6E	.030	.050	-.020	60.4	2.0
A7E	.033	.024	.009	42.0	1.0
AV8A	.046	.046	.000	24.6	1.0
F8J	.030	.034	-.004	34.0	1.0
F14A	.045	.035	.010	72.5	2.0
S3A	.161	.158	.003	52.5	4.0

STATISTICAL PARAMETERS:

REGRESSION EQUATION	MI = 0.0272 - 0.0012 (WTMXTO) +0.0491 (CREW)
CORRELATION COEFFICIENT	r = 0.9767
STANDARD ERROR OF ESTIMATE	S = 0.0123
CONFIDENCE LEVEL, 95%	2S = ±0.0246
NUMBER OF OBSERVATIONS	N = 7

FREQUENCY INDEX ESTIMATION - MA/FH O LEVEL

ACFT	3M FI		ERROR	WEIGHT MAXIMUM TAKEOFF X 10^3 LBS (WTMXTO)	CREW SIZE (CREW)
	ACTUAL	CALCULATED			
A4M	.016 *	.012	.004	24.5	1.0
A6E	.012	.026	-.014	60.4	2.0
A7E	.014	.006	.008	42.0	1.0
AV8A	.007	.012	-.005	24.6	1.0
F8J	.008	.009	-.001	34.0	1.0
F14A	.029	.022	.007	72.5	2.0
S3A	.084	.081	.003	52.5	4.0

STATISTICAL PARAMETERS:

REGRESSION EQUATION	FI = -0.0057 - 0.0003 (WTMXTO) +0.0262 (CREW)
CORRELATION COEFFICIENT	r = 0.9591
STANDARD ERROR OF ESTIMATE	S = 0.0095
CONFIDENCE LEVEL, 95%	2S = ±0.0190
NUMBER OF OBSERVATIONS	N = 7

* Drag Chute Data Excluded

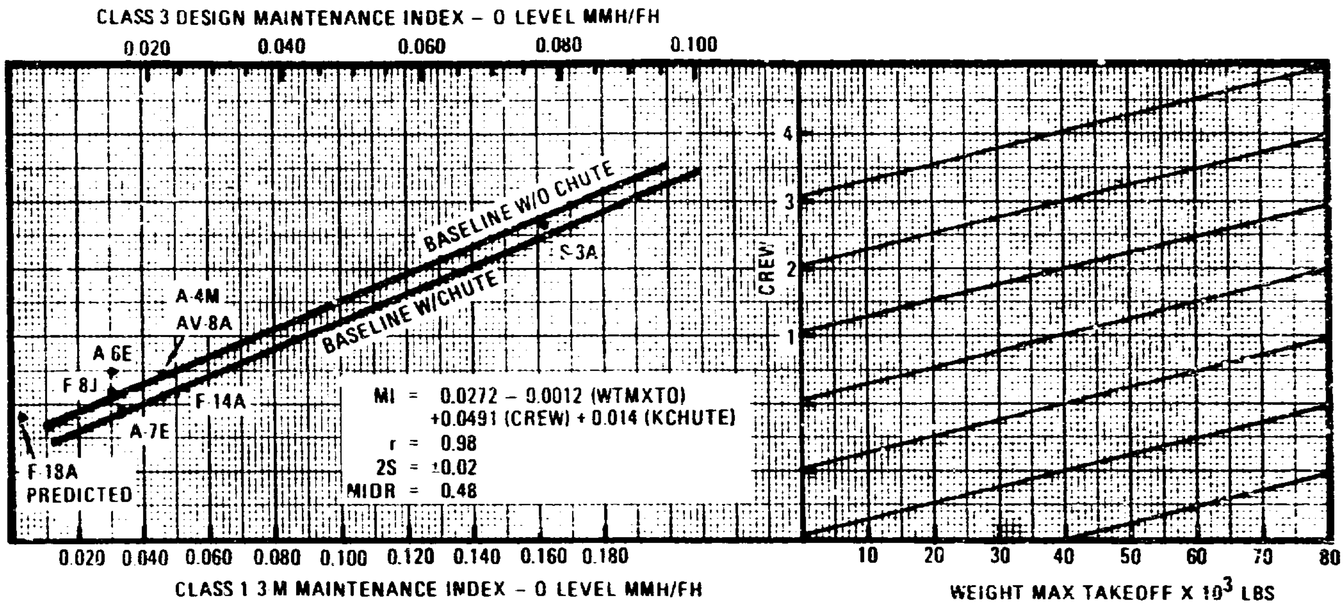


Figure 5.21-1 WUC 90 Maintenance Index Graph

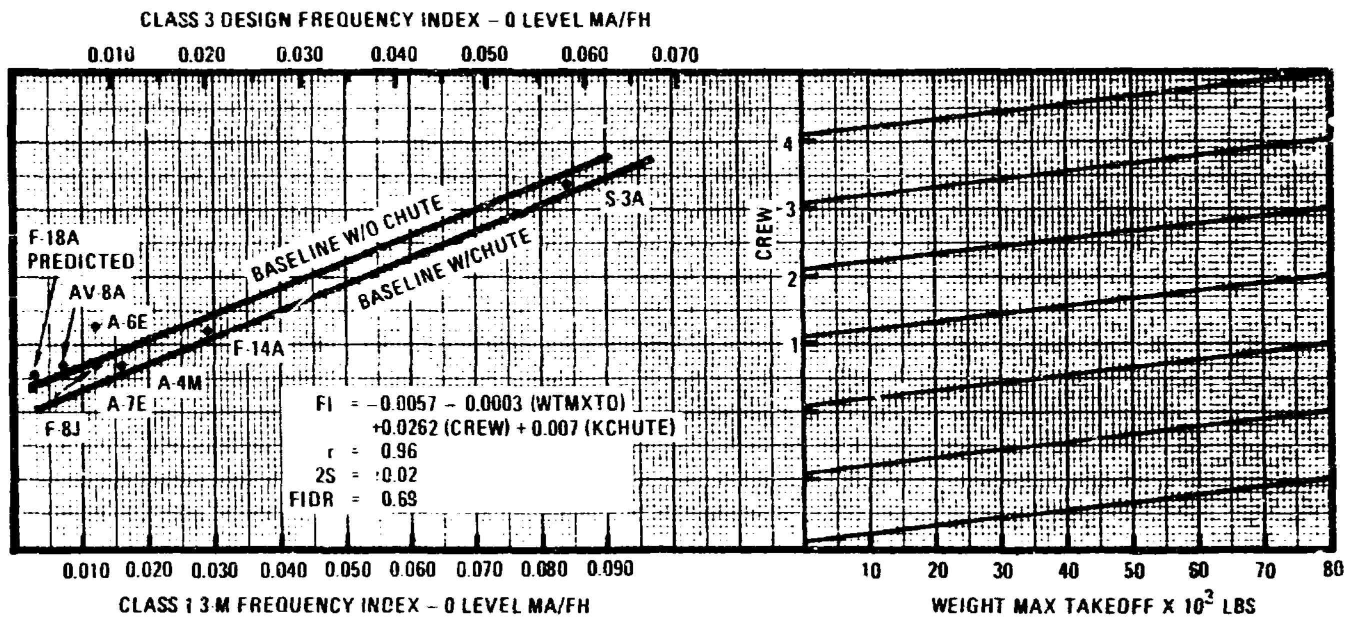


Figure 5.21-2 WUC 90 Frequency Index Graph

WUC: 90 CONTRACTOR:

SYSTEM: Miscellaneous Equipment AIRCRAFT MODEL:

PART I CONTRACTOR DATA

CONTRACTOR PREDICTIONS – CLASS 3 DESIGN MAINT. REQ.				
ML	MMH/FH	MA/FH	MMH/MA	EMT/MA
O				
I				

DESIGN/PERFORMANCE PARAMETERS	
Weight Maximum Takeoff, lbs. Crew Size Drag Chute Factor, 1 or 0	

PART II SYSTEM CONSTANTS

PARAMETER		BASE	PRED
MEN_O	AVG NO. MEN – O LEVEL	1.5	
MEN_I	AVG NO. MEN – I LEVEL	1.1	
MIIR	MMH/FH I LEVEL RATIO	.18	
FIIR	MA/FH I LEVEL RATIO	.16	

PART III SYSTEM ANALYSIS

PARAMETER	CALCULATION	BASELINE CLASS 1 3-M DATA (A)	PREDICTED CLASS 1 3-M DATA (B)	IMPROVEMENT (DEGRADATION) (C) Δ	%
MMH/FH_O (1)	MAINT INDEX GRAPH				
	BASELINE				
	PREDICTED				
MA/FH_O (2)	FREQ. INDEX GRAPH				
	BASELINE				
	PREDICTED				
MMH/MA_O (3)	$MMH/FH_O \div MA/FH_O$				
	÷				
	÷				
EMT/MA_O (4)	$MMH/MA_O \div MEN_O$				
	÷				
	÷				
MMH/FH_I (5)	$MMH/FH_O \times MIIR$				
	X				
	X				
MA/FH_I (6)	$MA/FH_O \times FIIR$				
	X				
	X				
MMH/MA_I (7)	$MMH/FH_I \div MA/FH_I$				
EMT/MA_I (8)	$MMH/MA_I \div MEN_I$				
$MMH/FH_{O,I}$ (9)	$MMH/FH_O + MMH/FH_I$				

FIGURE 5.21-3 Worksheet for Evaluating System Maintenance Requirements

PART III

EVALUATION AND ANALYSIS OF SELECTED COMPONENT INSTALLATIONS

6.0 FIVE DIGIT WORK UNIT CODE (COMPONENT) ANALYSIS

6.1 INTRODUCTION

The previous sections of this Handbook concerned an analysis of system level maintenance for use as a predictive tool on new procurement aircraft. Once the contract has been awarded, detailed design begun, and preliminary maintenance predictions on specific equipment made, a method to evaluate or compare these new designs to existing configurations, so as to retain the favorable maintenance features and avoid the poor maintenance features, would be an asset. Additionally, to know the relative costs, maintenance-wise, of given features would provide the necessary substantiation for acceptance or rejection of design trade-offs in terms of potential life cycle costs.

This section of the Aircraft Maintenance Experience Design Handbook addresses the relationships between certain qualitative features and their impact on maintenance. Components are grouped according to function and a discussion of how or why a particular feature drives the 3-M maintenance data is included. Supportive tables and graphs documenting the maintenance experienced in the Fleet are also presented as adjunctive pages to the discussions.

A general statement concerning component design may be drawn from the analyses of component qualitative and quantitative data presented here. That is, whenever operational availability of aircraft is of paramount concern, planners must give weighted consideration to the fact that equipment failures will occur at critical points during aircraft utilization regardless of the projected or realized MTBF. At this time, the single factor limiting recovery and mission operation success or continuance is the elapsed time required to affect a "fix". In the majority of instances a remove and replace action on a component will constitute the "fix". Therefore, the maintainability aspects of installation design must be emphasized for all systems critical to mission success. Toward this end, the analysts' major recommendations contained in this section of the Handbook and formulated from the qualitative data available, common maintainability practices and previous maintenance experience may be summarized as follows:

1) Restrict the number and type of fasteners/latches associated with frequently used access panels. This can be accomplished by utilizing one or more of the following: use hinged doors with quick release latches, use quick release fasteners instead of screws, or break large surface panels into several smaller ones held in place with quick release fasteners.

2) Require that Built-in-Test provisions or Built-in-Test Equipment be made an integral part of all new designs to satisfy all after installation serviceability/functional checks, including integrated systems checks, when applicable, to eliminate the need for peculiar ground support equipment or test equipment.

3) Utilize rack and panel type connectors on electronic equipment wherever possible even if its use dictates design of an adapter to convert the wide

variety of equipment now available to rack and panel type mounting; and promote the further development of rack and panel connector technology.

4) Disallow removal or disruption of adjacent non-associated equipment/ hardware to accomplish a removal or adjustment action.

Adoption of these recommendations and others made on specific functional components in part or in whole would improve the installation, maintainability-wise, thus enhancing the "fix" time and increasing the availability of the aircraft for its intended mission.

6.2 BASIS OF QUALITATIVE AND QUANTITATIVE DATA USED

6.2.1 Qualitative Data

Two studies, accomplished by Vought Corporation (References 6 and 21) for Naval Air Systems Command (NAVAIR), delved into the qualitative aspects of a select list of maintenance significant components. Candidate components evaluated in these studies were selected on the basis of elapsed maintenance time and frequency of maintenance as exhibited in Navy 3-M data. The final list of component installations investigated was based on those candidate items which were available at the survey sites. A total of nine Navy aircraft were involved in the two studies: A-4M, A-6E, A-7E, F-4J, F-8J, F-14A, AV-8A, P-3C and S-3A. Functionally similar components, when available, were evaluated on all aircraft whether or not they were indicated by 3-M as maintenance burdens. This allowed a comparison of strong and weak features to be made. The study investigators evaluated the selected components in the light of what must be done to remove, replace, and functionally check the item. In other words, how good was a particular design in facilitating maintenance? How good was the product's installation maintainability? Evaluations were made without regard to design trade-offs or acknowledged maintainability compromises, and, as such, are representations of ideal maintainability constraints.

These two studies form the base from which the qualitative considerations presented in the component discussions in this Handbook are drawn.

6.2.2 Quantitative Data

Data used in this Handbook was derived from the Navy Maintenance, Management and Material (3-M) System. The majority of the data used was obtained from the Naval Aviation Logistics Center (NALC) through the use of their ASMRA (Adjustment of Scheduled Maintenance Requirements through Analysis) programs, References 2 through 4. Flight hours for the time period covered were obtained from the Navy Fleet Maintenance Support Office (FMSO) via the Fleet Weapon System Reliability and Maintainability Statistical Summary Tabulation, Reference 9.

Specifically, the ECIP (Equipment Cross Index Program) series of the ASMRA programs provided all of the maintenance data required except average remove and replace time. This average remove and replace time was obtained from the ECA (Equipment Condition Analysis) series of ASMRA programs. A more detailed description of the processes used by the ASMRA system to process Navy 3-M data can be found in Appendix D.

Data for all the aircraft, except the F-8J and the remove and replace values, represents the time period of July, 1975 through December, 1976. Because the F-8J was being phased out during this period, an older more representative base was needed and the period selected was July, 1974 through December, 1975. The remove and replace data available through the ASMRA ECA programs were also for an eighteen month period, however, the period was January, 1975 through July, 1976. The difference in data base time frame for the remove and replace actions is not deemed significant since these actions remain relatively constant and numbers presented are an average value for all like actions.

6.3 PRESENTATION

6.3.1 General Organization

Each of the functional component analyses is presented in three sheets. The first is a tabular display of the 3-M maintenance data each aircraft experienced during the selected time frame, for the Work Unit Codes listed. The second is a graphical presentation of several Organizational parameters deemed the most significant in describing the maintainability/maintenance costs of a component. Finally, the third is a comparison of the quantitative data presented on sheets one and two and the qualitative data contained in the Qualitative Maintenance Experience Handbook and the supplement thereto (References 6 and 21). The comparison emphasizes the remove and replace quantitative data since it relates most directly to the qualitative information.

6.3.1.1 Tabular 3-M Maintenance Data

The data experienced by each aircraft in the study is displayed in a series of tables. There is a table for each set of functional components described in References 6 and 21. The tables are identified by the functional component nomenclature e.g. Nose Landing Gear Wheel and Tire Assembly.

The next entry on the page describes which components were investigated by elaborating the precise Work Unit Codes (WUCs) for which 3-M maintenance data was extracted. Work Unit Code Manuals, (References 22 through 30) document Work Unit Codes to equipment nomenclature for each aircraft. Equipment surveyed is annotated by the fifth level of indenture Work Unit Code. Data presented in the tables include all 3-M maintenance information reported to this fifth level of indenture plus all maintenance recorded to more detailed subcomponents at the seventh level of indenture. Additionally, where a Work Unit Code ended in a zero, data was compiled for all WUCs comprising that system code (fourth level of indenture). For example, if the WUC was 14360, then the data presented in the table represents the summation of maintenance reported for all codes beginning 1436. This was required because of the lack of definition concerning the components evaluated in the qualitative studies (References 6 and 21).

Historical data is presented for both Organizational level maintenance and Intermediate level maintenance. Data elements presented for the Organizational level are: Flight Hours, Mean Flight Hours Between Maintenance Actions (MFHBMA), Maintenance Actions per Flight Hour (MA/FH), Mean Time To Repair (MTTR), Maintenance Manhours per Maintenance Action (MMH/MA), Men per Maintenance Action (MEN/MA), Maintenance Manhours per Flight Hour (MMH/FH), Remove and Replace time (R+R) and Organizational plus Intermediate level Mean Time Between Failures

(O + I MTBF). Data elements presented for the Intermediate level of maintenance are the same as for Organizational less R+R and O + I MTBF, which are not applicable to that level. For the purpose of the analyses in this Handbook, MTTR is defined to mean the amount of clock time per action required to affect a repair or adjustment and is numerically determined by dividing the elapsed maintenance time (EMT) by the number of maintenance actions (MA). The parameter, R+R, is defined as the average time required to remove and replace an item as determined by the value EMT/MA for <u>only</u> those actions which are coded Action Taken Code "R". The definitions of the remainder of the data elements presented are self explanatory.

The Intermediate level data presented herein is for informational purposes only.

6.3.1.2 Graphical 3-M Maintenance Data

Several of the data elements from the tabular pages are also displayed graphically as an aid in comparing component installation experience by aircraft and to facilitate comparison of the quantitative data to the qualitative features. The data elements MTTR, MEN/MA, and R+R were chosen because they best describe the impact a component installation has on the maintenance technician and on the relative costs of maintenance; thus, summarizing the on-aircraft maintainability aspects of the component.

Maintenance Manhours per Flight Hour (MMH/FH) was also selected because traditionally, maintainability impact is measured in this quantity. Finally, O + I MTBF was chosen to provide information of an additional design trade-off quantity to the user. A more detailed description of the ASMRA system data processing and the definition of failure used by the ASMRA system in calculating O + I MTBF can be found in Appendix D.

6.3.1.3 Comparative Discussions.

The objective of this sheet is to set forth what designers may expect to incur in the way of savings or penalties by using a design similar to, or the same as, current designs. These costs are based on what a similar design or design trait is experiencing in the Fleet. In other words, what qualitative features drive the quantitative values reported in 3-M up or down? To answer this question the data element R+R and to some extent the data elements MTTR and MEN/MA are evaluated and compared to the qualitative design information in the <u>Qualitative Maintenance Experience Handbook</u> as supplemented, (References 6 and 21). These three elements were chosen because they best describe the effects of the design on the maintainability of the component and are not affected by frequency of failure or utilization.

The qualitative information presented in the comparative discussions is only that information which was needed to answer the above question and is not indicative of the total information contained in the <u>Qualitative Maintenance Experience Handbook</u> (References 6 and 21).

6.3.2 Detailed Procedures for Using the Data Presented

The total data package presented is meant as a guide for the designer and the person evaluating the design. It is meant to provide an appreciation of the

maintenance costs associated with a particular design feature currently in use. With this information in hand, decisions on new design, design trade-offs, or design changes can be made with the previous maintenance experience in mind.

The starting point in the use of this portion of the Handbook is the comparative description. This section is an analysis of the quantitative and qualitative data. The description analyzes why, in terms of peculiar design features, the same functional component has different maintenance/maintainability costs. After reading the description, the Handbook user can then consult the tabular and graphical displays. From these two presentations, additional information can be obtained to support a decision on a particular design. Use of MMH/FH or MMH/MA can give the relative labor impact. Studying the variations in MFHBMA and MTBF can give insight as to the reliability and frequency of maintenance. Flight hours is a clue to aircraft utilization; which, when combined with the operational nature of the component, will give a good indication of the utilization of the component. Intermediate level quantitative data can then be included to further expand the scope of the evaluation.

The total information package thus presented may then be used to assist the Handbook user in making design decisions.

6.4 ADDITIONAL NOTES AND CONSTRAINTS

In some instances the tabular data will have a blank line entry for an aircraft instead of detailed maintenance data. This blank line is used to indicate that the aircraft's particular functional component was not evaluated qualitatively, or that the quantitative data did not reflect any maintenance activity for that component. The lack of a qualitative description was caused by either the lack of availability of the component during the qualitative survey, or the lack of a similar component on that aircraft because of design, configuration, or mission requirement. The use of the symbol N/A, not available or applicable, in the Work Unit Code portion of the page is also indicative of this condition.

Occasionally, the quantitative data on the tabular printout will indicate general maintenance was performed during the eighteen month period, but no remove and replace actions occurred, or vice versa. In most instances this is a valid situation because all of the maintenance involved adjustments or repair of the component on-aircraft and no paper work was initiated with Action Taken Code "R", Remove and Replace. Likewise, because of the slight difference in time frames between the remove and replace data and the remainder of the data, remove and replace data may be depicted without the corresponding general maintenance data. Where this occurs, the analysts have determined the cause and appropriate comments are made in the comparative discussions.

Additionally, the analysts have attempted to avoid making comparisons of qualitative features to quantitative values whenever the sample size made the value statistically suspect. When this occurred, the parameter was discounted from the analyses and mentioned in the narrative. Specifically, if the maintenance data comprised a sample size of ten or less it was investigated to determine if it was statistically representative. In some instances larger samples were discounted because the available information indicated inconsistencies between the data sources. In other instances smaller sample sizes were

considered valid because of the substantive agreement between the sources.

During the analyses of the component installations, notice was taken of the occasional apparent disparities between the two sets of data obtained from the ASMRA system. Both sets of data share a common twelve months with the remainder of the eighteen months of data being at either end of the common time. At times, resultant overlap provided unrealistic numbers. For example, the F-14A Automatic Flight Control System computers/amplifiers quantitatively indicated 527 remove and replace actions in the eighteen months of the ASMRA Equipment Condition Programs data and only one action overall in the ASMRA Equipment Cross-Index Program data. The later base should have reflected the majority of the remove and replace actions since it is unreasonable to assume maintenance would drop from over 500 actions in six months to one in the next eighteen. These occasional abnormalities, such as the one just described, were never resolved and the analysts chose to invalidate the data for these components when this situation existed. This is not to say that the data was erroneous but rather the validity could not be established.

TABLE 6.01 MAINTENANCE DATA - COCKPIT CANOPY

WORK UNIT CODES

A-4	11361	A-6	11122	A-7	12110	AV-8	12110	F-4	11184
F-8	N/A	F-14	11111	P-3	N/A	S-3	N/A		

ORGANIZATIONAL LEVEL

A/C	FLIGHT HOURS	MFHBMA	MA/FH X10-3	MTTR	MMH/MA	MEN/MA	MMH/FH	R+R	O+I MTBF
A-4M	35,571	508.2	2.0	1.63	4.69	2.9	.009	12.75	1,078
A-6E	87,564	77.3	12.9	1.75	3.62	2.1	.047	2.82	130
A-7E	159,611	79.9	12.5	3.04	6.38	2.1	.080	16.33	146
AV-8A	19,396	104.3	9.6	2.27	4.43	1.9	.042	6.33	175
F-4J	115,070	99.9	10.0	3.05	5.95	1.9	.060	15.06	139
F-8J	18,317								
F-14A	51,286	67.8	14.7	1.92	3.66	1.9	.054	8.37	105
P-3C	125,860								
S-3A	60,552								

INTERMEDIATE LEVEL

A/C	FLIGHT HOURS	MFHBMA	MA/FH X10-3	MTTR	MMH/MA	MEN/MA	MMH/FH
A-4M	35,571	8,892.8	0.1	5.93	11.28	1.9	.001
A-6E	87,564	3,980.2	0.3	2.90	4.58	1.6	.001
A-7E	159,611	4,313.8	0.2	4.54	7.11	1.6	.002
AV-8A	19,396	2,424.5	0.4	1.64	2.76	1.7	.001
F-4J	115,070	2,130.9	0.5	1.07	1.09	1.0	.001
F-8J	18,317						
F-14A	51,286	2,331.2	0.4	31.90	75.07	2.4	.032
P-3C	125,860						
S-3A	60,552						

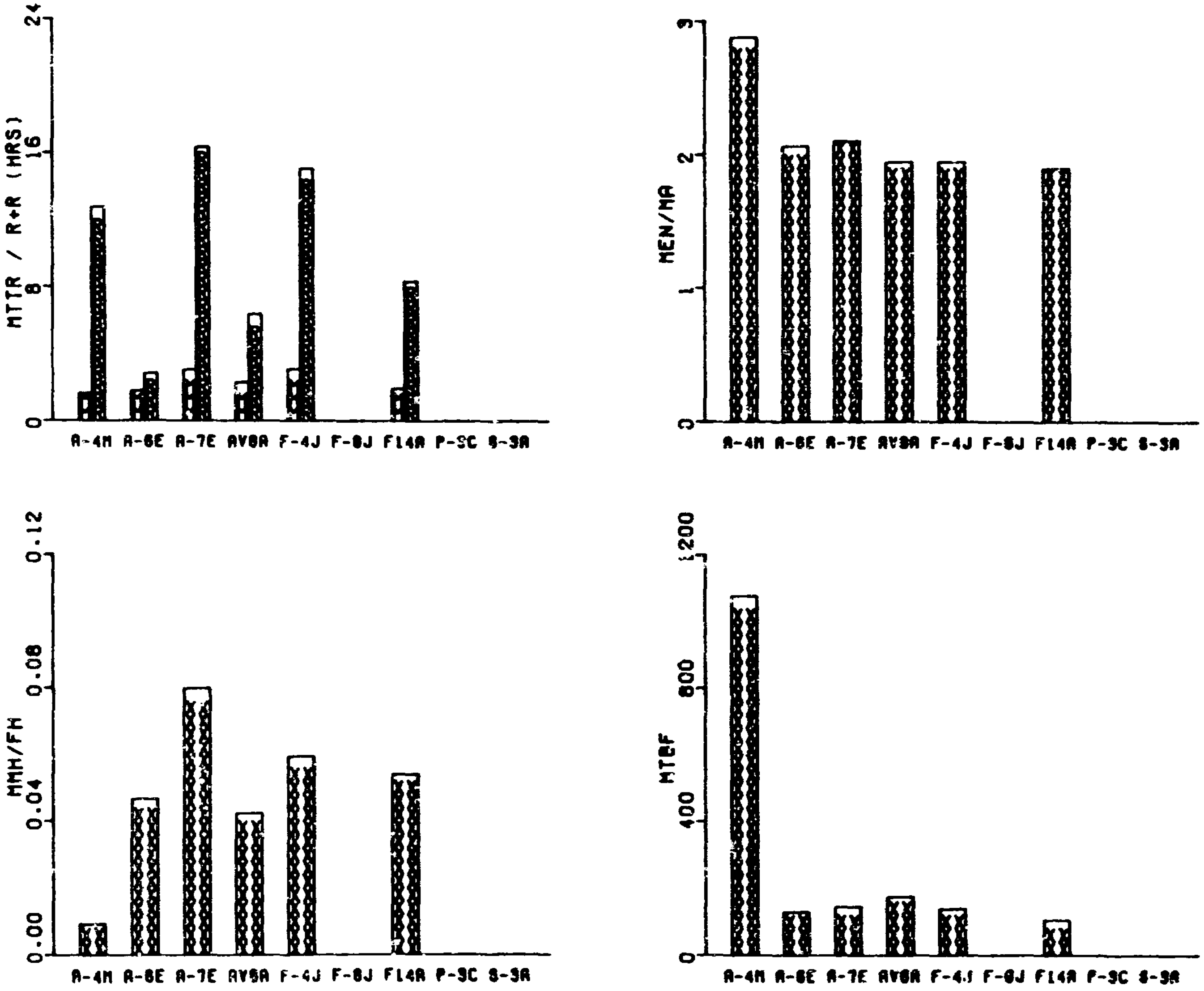


FIGURE 6.01 SELECTED GRAPHICAL DATA - COCKPIT CANOPY

6.5 AIRFRAME/FUSELAGE SYSTEM

6.5.1 Cockpit Canopy (See preceding Table and Figure 6.01)

WORK UNIT CODES

A-4 11361	A-6 11122	A-7 12110	AV-8 12110	F-4 111B4
F-8 N/A	F-14 11111	S-3 N/A	P-3 N/A	

DISCUSSION

Comments:

The A-6E and F-14A cockpit canopies are the two best installations qualitatively and this is reflected in the quantitative values. These canopies have few removal steps, they either slide off or automatically disconnect at a given angle, and they are easily removed. No intermediate disassembly tasks are needed as in the F-4J and A-7E. The AV-8A's lightweight canopy (it can be carried by hand) contributes to its lower than average R+R time. The A-7E and A-4M require depressurization of a bungee or counterbalance cylinder and later servicing of same. These additional steps add to the higher R+R time. The A-7E and F-4J canopies require much disassembly and some of the hardware is difficult to reach. The extra complexity of the F-4J and A-7E is definitely reflected in their MTTR and R+R times.

Recommendations:

Canopy designs should be lightweight, avoid use of nitrogen pressurized cylinders, and be removable with a minimum of removal steps to lessen the maintenance burden.

Canopy seal design should also be optimized as any rigging or pressurization problems will affect R+R time.

Avoid the use of loose spacers in canopy installations. Loose spacers are easily dropped/lost and are awkward to use. When spacers must be utilized, employ fixed spacers (spacers permanently attached to the unit).

TABLE 6.02 MAINTENANCE DATA - RADOME

WORK UNIT CODES

A-4	11112	A-6	11111	A-7	11120	AV-8	11110	F-4	11112
F-8	11121	F-14	11121	P-3	11123	S-3	11124		

ORGANIZATIONAL LEVEL

A/C	FLIGHT HOURS	MFHBMA	MA/FH X10-3	MTTR	MMH/MA	MEN/MA	MMH/FH	R+R	O+I MTBF
A-4M	35,571	988.1	1.0	2.48	3.05	1.2	.003	1.70	1,112
A-6E	87,564	177.6	5.6	2.91	5.41	1.9	.030	5.72	221
A-7E	159,611	406.1	2.5	2.63	4.97	1.9	.012	5.75	494
AV-8A	19,396	114.1	8.8	2.36	4.60	1.9	.040	6.13	340
F-4J	115,070	190.2	5.3	1.96	3.74	1.9	.020	3.97	294
F-8J	18,317	469.7	2.1	2.25	3.23	1.4	.007	2.33	833
F-14A	51,286	318.5	3.1	1.99	4.86	2.4	.015	4.02	641
P-3C	125,860	306.2	3.3	2.28	5.20	2.3	.017	2.59	496
S-3A	60,552	455.3	2.2	1.91	3.54	1.9	.008	3.11	637

INTERMEDIATE LEVEL

A/C	FLIGHT HOURS	MFHBMA	MA/FH X10-3	MTTR	MMH/MA	MEN/MA	MMH/FH
A-4M	35,571	17,785.5	0.1	12.85	12.85	1.0	.001
A-6E	87,564	12,509.1	0.1	1.36	3.14	2.3	.000
A-7E	159,611	8,400.6	0.1	4.97	8.04	1.6	.001
AV-8A	19,396	3,232.7	0.3	5.58	10.58	1.9	.003
F-4J	115,070	4,261.9	0.2	11.63	13.74	1.2	.003
F-8J	18,317	3,663.4	0.3	7.88	8.00	1.0	.002
F-14A	51,286	2,442.2	0.4	5.55	8.67	1.6	.004
P-3C	125,860	1,534.9	0.7	18.61	31.52	1.7	.021
S-3A	60,552	2,883.4	0.3	18.28	23.77	1.3	.008

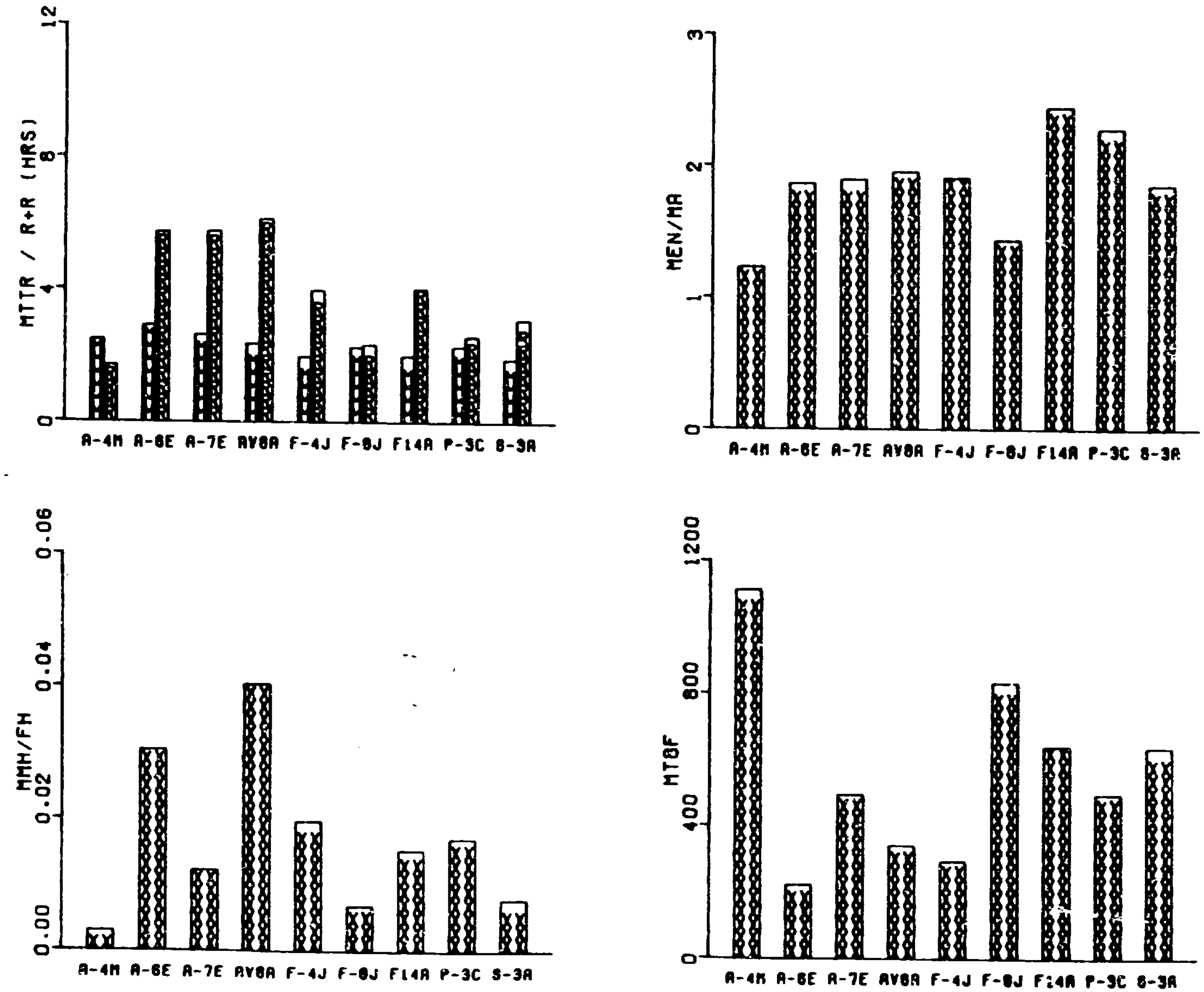


FIGURE 6.02 SELECTED GRAPHICAL DATA - RADOME

6.5.2 Radome (See preceding Table and Figure 6.02)

WORK UNIT CODES

A-4 11112	A-6 11111	A-7 11120	AV-8 11110	F-4 11112
F-8 11121	F-14 11121	P-3 11123	S-3 11124	

DISCUSSION

Comments:

The AV-8A is considered qualitatively the least desirable installation and is so reflected by maintenance experience. Pitot static lines must be disconnected; the radome is large considering the size of the overall aircraft; several access panels must be removed; and a reaction nozzle must be displaced to allow sufficient clearance. *These features are reflected in the AV-8A's high R+R time.* The A-7E and A-6E, which fall next in line quantitatively, have either attach points which are difficult to work on or have an array of opening devices which add complexity to the installation. Physical size of the P-3C and F-14A radomes by necessity adds to the MMH/MA and quantity of personnel required. Utilization of quick release pip pins allows for improved MTTR and R+R on the S-3A. Easy access and minimized quantity of attach bolts is a strong point which allowed A-4M maintenance people to remove and replace the radome so rapidly.

Recommendations:

Optimization of maintenance parameters can be expected by maximizing the use of quick release pip pins, reducing the quantity of attachments, allowing sufficient access around attach points, and by incorporating a easy to use jury strut as part of the radome installation.

Avoid removal or displacement of unassociated systems as this generally will require a marked increase in maintenance expenditures.

TABLE 6.03 MAINTENANCE DATA - EJECTION SEATS/PILOTS-COPILOTS SEAT

WORK UNIT CODES

A-4	12110	A-6	12110	A-7	12210	AV-8	12210	F-4	12230
F-8	12260	F-14	12111	P-3	12113	S-3	12111		

ORGANIZATIONAL LEVEL

A/C	FLIGHT HOURS	MFHBMA	MA/FH X10-3	MTTR	MMH/MA	MEN/MA	MMH/FH	R+R	O+I MTBF
A-4M	35,571	248.7	4.0	1.80	3.24	1.8	.013	4.50	647
A-6E	87,564	833.9	1.2	2.41	4.51	1.9	.005	2.61	1,946
A-7E	159,611	221.4	4.5	2.80	4.98	1.8	.022	3.96	823
AV-8A	19,396	33.8	29.6	1.71	3.13	1.8	.093	2.23	131
F-4J	115,070	7.1	140.5	1.66	2.84	1.7	.399	2.39	52
F-8J	18,317	54.8	18.2	2.42	4.17	1.7	.076	2.04	138
F-14A	51,286	80.4	12.4	1.98	3.32	1.7	.041	0.50	111
P-3C	125,860	234.8	4.3	0.99	1.40	1.4	.006	1.89	437
S-3A	60,552	191.0	5.2	2.96	7.34	2.5	.038	5.34	546

INTERMEDIATE LEVEL

A/C	FLIGHT HOURS	MFHBMA	MA/FH X10-3	MTTR	MMH/MA	MEN/MA	MMH/FH
A-4M	35,571	5,928.5	0.2	2.92	5.08	1.7	.001
A-6E	87,564	17,512.8	0.1	1.30	1.70	1.3	.000
A-7E	159,611	3,711.9	0.3	0.75	1.05	1.4	.000
AV-8A	19,396	668.8	1.5	0.63	0.98	1.6	.001
F-4J	115,070	348.7	2.9	1.90	2.68	1.4	.008
F-8J	18,317	1,308.4	0.8	0.51	0.51	1.0	.000
F-14A	51,286	12,821.5	0.1	0.88	0.88	1.0	.000
P-3C	125,860	2,677.9	0.4	7.28	9.00	1.2	.003
S-3A	60,552	3,027.6	0.3	0.55	0.60	1.1	.000

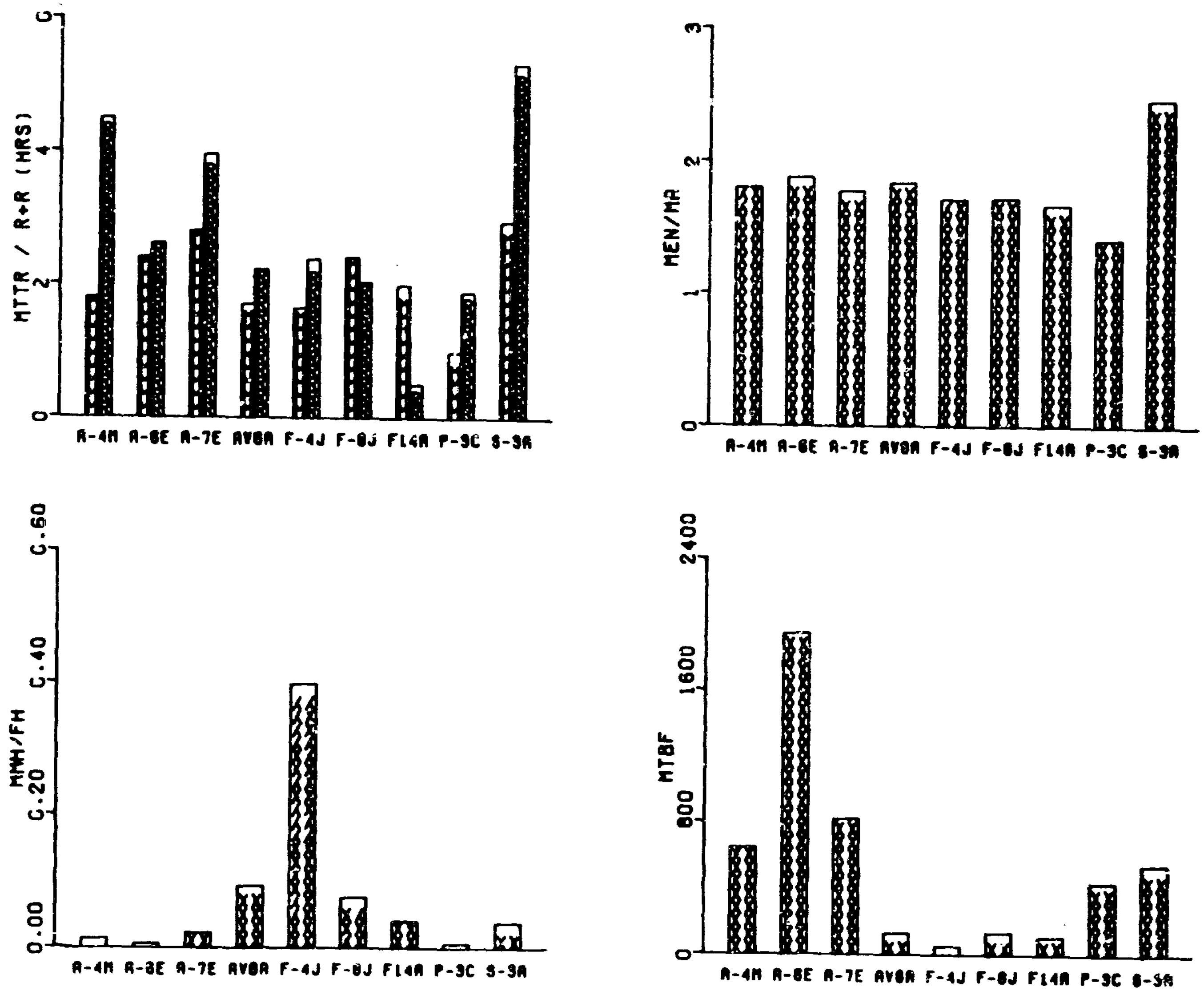


FIGURE 6.03 SELECTED GRAPHICAL DATA - EJECTION SEATS/PILOTS-COPILOTS SEAT

6.5.3 Ejection Seats/Pilot's - Copilot's Seat (See preceding Table and Figure 6.03)

WORK UNIT CODES

A-4 12110	A-6 12110	A-7 12210	AV-8 12210	F-4 12230
F-8 12260	F-14 12111	P-3 12113	S-3 12111	

DISCUSSION

Comments:

The ejection seat is a component designed to operate only once in the life of the aircraft. The safety aspects of its use make it a prime candidate for periodic preventative maintenance but generally the seat should not require replacement on an unscheduled basis. Examination of the data sample size for R+R reflects this general maintenance concept. The R+R quantitative data is not representative enough to make conclusions as to the relative maintenance costs inherent in the individual installations, and only the P-3C, which does not have an ejection seat, recorded a significant quantity of removals in eighteen months. In general, the aircraft with Martin-Baker seats (A-6E, AV-8A, F-4J, F-8J and F-14) present a slightly lower maintenance burden overall than Douglas Escapac seats (A-4M, A-7E, S-3A) in terms of MTTR and MMH/MA. The qualitative information available for this analysis dealt with the ability of Organizational people to remove and replace the seat. In this regard, certain qualitative traits can be expected to impact the replacement times. Among these is the need to displace or remove canopies or hatches. Although a necessity because of canopy design and because all the ejection seats slide up and down on an inclined set of rails, some of the canopy/hatch removals are intricate and time consuming adding significant expense. The S-3A is a prime example requiring over 100 High Torque screws be removed to affect seat removal. It can be assumed that a number of repairs falling in a non Action Taken Code "R" (remove and replace) category actually necessitated seat removal and these more lengthy fixes reflect an increase in time in the MTTR and MMH/MA depicted. These increases in maintenance expense could have been reduced on some installations had the canopy removals/displacements been limited.

Recommendations:

Avoid, if at all possible, ejection seat designs which require complete canopy removal or extensive disassembly of canopy attachments to affect ejection seat removal. Removing or displacing unassociated equipment requires valuable mission ready time and resources.

Eliminate the need to remove seats to gain access to other equipment or to provide working space for nearby components. Disturbing this essential safety item for no cause is not only costly but increases the risks of potential problems with the seat.

Ejection seats should be designed to minimize scheduled preventative maintenance requirements with a goal of necessitating removal only when the entire aircraft is inducted into the depot. Toward this end, seats should be of a modular design allowing for centrally located plug in explosive devices with an access panel provided in the seat back. Similarly, seat associated components such as parachutes and survival kits also should be designed modular and tied to the same maintenance schedule as the seat.

TABLE 6.04 MAINTENANCE DATA - MAIN ENTRANCE DOOR

WORK UNIT CODES

A-4	N/A	A-6	N/A	A-7	N/A	AV-8	N/A	F-4	N/A
F-8	N/A	F-14	N/A	P-3	11228	S-3	1113A		

ORGANIZATIONAL LEVEL

A/C	FLIGHT HOURS	MFHBMA	MA/FH X10-3	MTTR	MMH/MA	MEN/MA	MMH/FH	R+R	O+I MTBF
A-4M	35,571								
A-6E	87,564								
A-7E	159,611								
AV-8A	19,396								
F-4J	115,070								
F-8J	18,317								
F-14A	51,286								
P-3C	125,860	316.2	3.2	1.48	2.47	1.7	.008	2.57	413
S-3A	60,552	180.2	5.5	2.07	3.41	1.6	.019	3.58	255

INTERMEDIATE LEVEL

A/C	FLIGHT HOURS	MFHBMA	MA/FH X10-3	MTTR	MMH/MA	MEN/MA	MMH/FH
A-4M	35,571						
A-6E	87,564						
A-7E	159,611						
AV-8A	19,396						
F-4J	115,070						
F-8J	18,317						
F-14A	51,286						
P-3C	125,360	20,976.7	0.0	15.75	19.25	1.2	.001
S-3A	60,552	15,138.0	0.1	17.80	23.58	1.3	.002

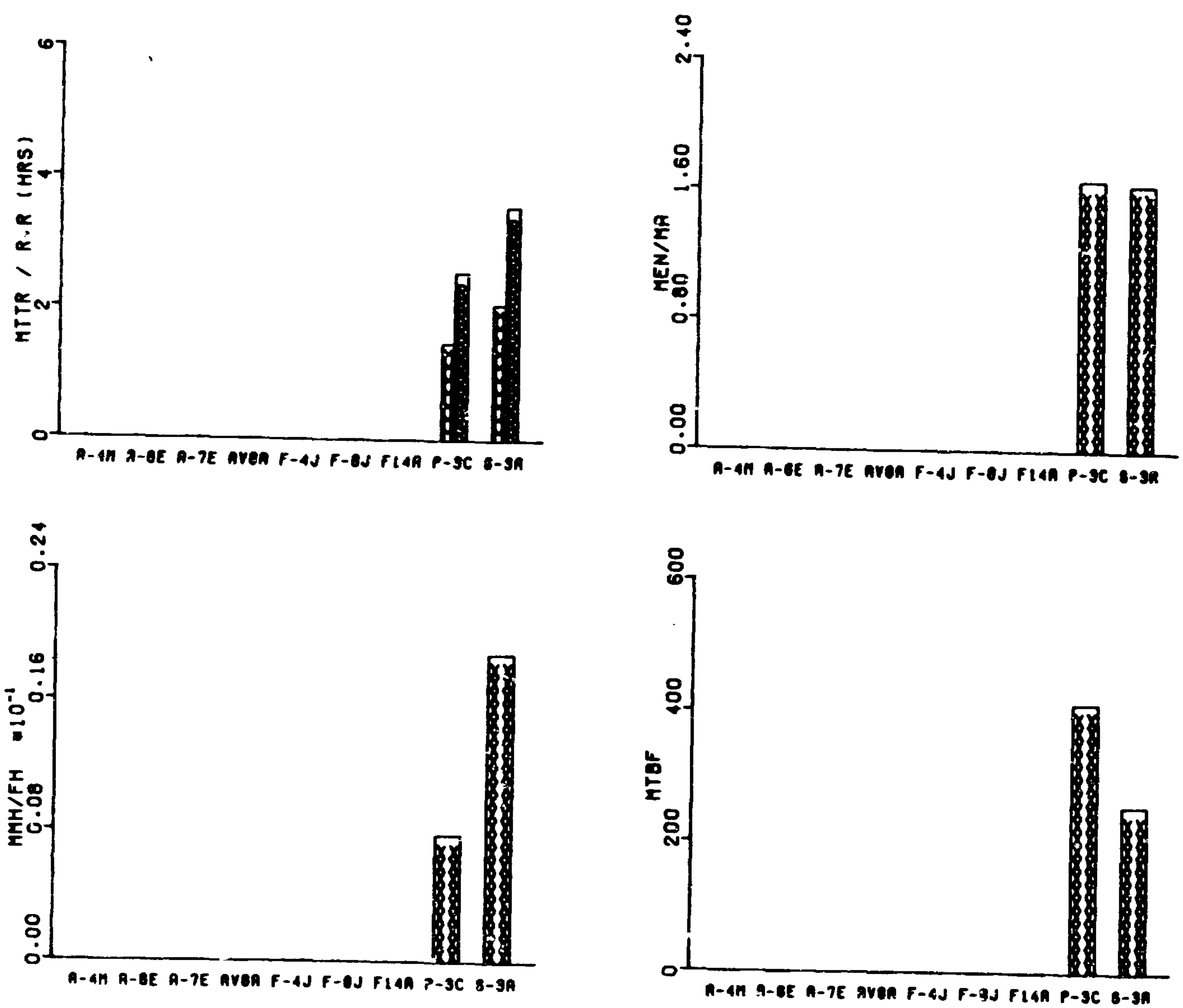


FIGURE 6.04 SELECTED GRAPHICAL DATA - MAIN ENTRANCE DOOR

6.5.4 Main Entrance Door (See preceding Table and Figure 6.04)

WORK UNIT CODES

A-4 N/A	A-6 N/A	A-7 N/A	AV-8 N/A	F-4 N/A
F-8 N/A	F-14 N/A	P-3 11228	S-3 1113A	

DISCUSSION

Comments:

Only two aircraft have personnel doors, the remainder have cockpit canopies. The design of these two doors is markedly different making comparative analysis difficult. The weight and size of the P-3C door and the difficulty in setting the tension on the door closing cable on the S-3A door add some extra time to the R+R values.

Recommendations:

When plastic is used to create lighter weight doors, it should be of a highly durable, impact resistant material.

Doors, which are also to be used as steps, should be designed with sufficient strength to not only hold the weight of flight crews, but also of personnel carrying heavy equipment into the aircraft.

When tension regulators are employed, self adjusting regulators requiring little or not adjustment are preferred.

TABLE 6.05 MAINTENANCE DATA - CANOPY ACTUATOR

WORK UNIT CODES

A-4	11365	A-6	N/A	A-7	12126	AV-8	12123	F-4	12315
F-8	12141	F-14	12521	P-3	N/A	S-3	N/A		

ORGANIZATIONAL LEVEL

A/C	FLIGHT HOURS	MFHBMA	MA/FH X10-3	MTTR	MMH/MA	MEN/MA	MMH/FH	R+R	O+I MTBF
A-4M	35,571	539.0	1.9	1.06	1.58	1.5	.003	1.63	1,046
A-6E	87,564								
A-7E	159,611	166.3	6.0	0.98	1.40	1.4	.008	3.05	198
AV-8A	19,396	179.6	5.6	3.13	4.41	1.4	.025	4.02	273
F-4J	115,070	485.5	2.1	3.40	6.18	1.8	.013	5.25	665
F-8J	18,317	1,077.5	0.9	1.76	2.68	1.5	.002	2.50	1,221
F-14A	51,286	431.0	2.3	4.27	10.66	2.5	.025	6.46	618
P-3C	125,860								
S-3A	60,552								

INTERMEDIATE LEVEL

A/C	FLIGHT HOURS	MFHBMA	MA/FH X10-3	MTTR	MMH/MA	MEN/MA	MMH/FH
A-4M	35,571	5,081.6	0.2	1.61	2.19	1.4	.000
A-6E	87,564						
A-7E	159,611	1,564.8	0.6	4.91	6.02	1.2	.004
AV-8A	19,396	19,396.0	0.1	0.50	0.50	1.0	.000
F-4J	115,070	1,643.9	0.6	5.25	6.97	1.3	.004
F-8J	18,317	2,289.6	0.4	0.31	0.56	1.8	.000
F-14A	51,286	732.7	1.4	6.18	9.99	1.6	.014
P-3C	125,860						
S-3A	60,552						

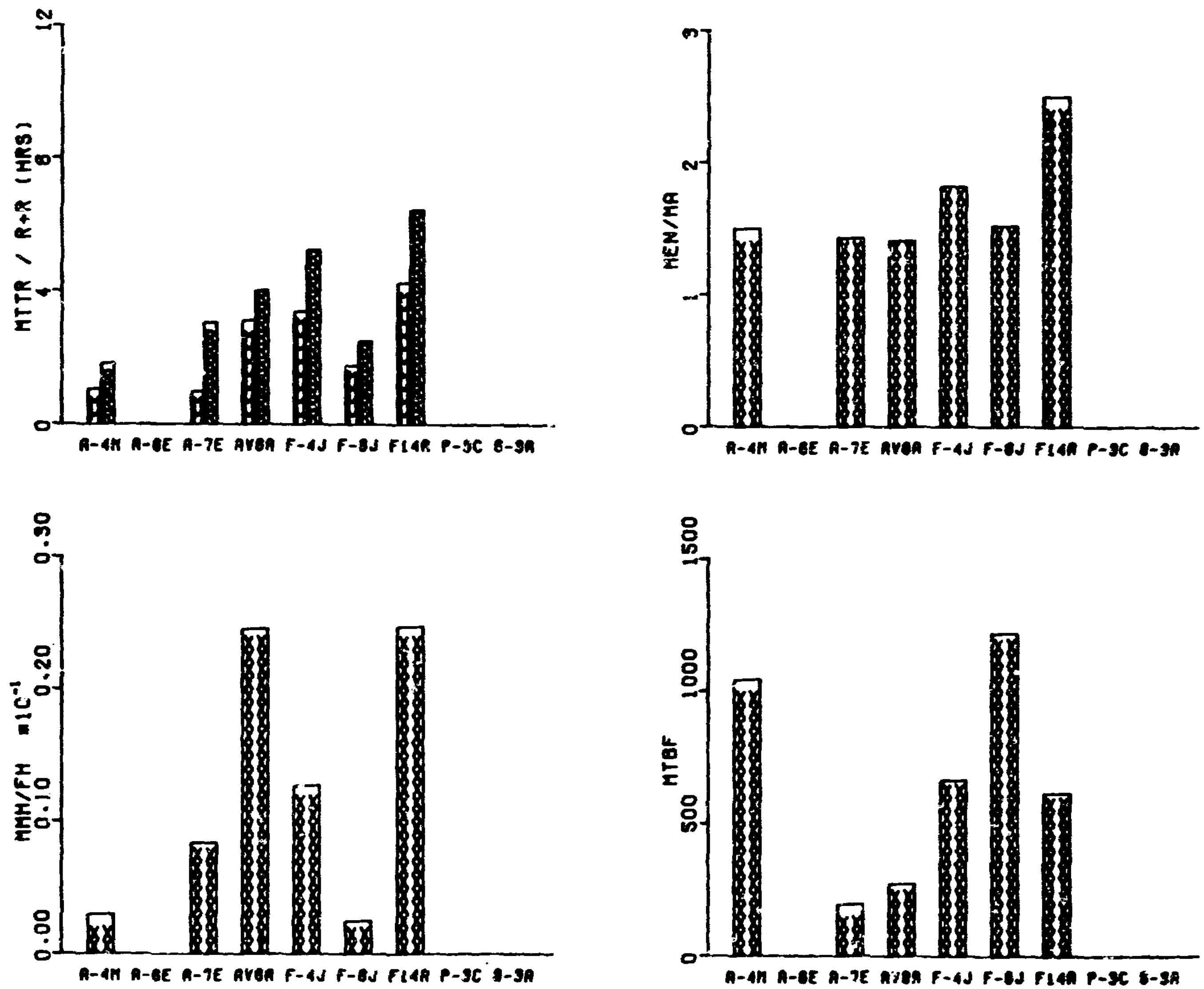


FIGURE 6.05 SELECTED GRAPHICAL DATA - CANOPY ACTUATOR

6.5.5 Canopy Actuator (See preceding Table and Figure 6.05)

WORK UNIT CODES

A-4 11365	A-6 N/A	A-7 12126	AV-8 12123	F-4 12315
F-8 12141	F-14 12521	P-3 N/A	S-3 N/A	

DISCUSSION

Comments:

Canopy actuators which act as mechanical assists will have lower maintenance rates than those actuators which are power driven. The A-4M, A-7E, AV-8A, and F-8J use a mechanical assist actuator. The A-4M, characterized by good access to attach points and requiring no panel removal, is also the best installation quantitatively. The A-7E requires a structurally restricted panel with 50 screws to be removed and this task can be seen as accounting for part of the increase in R+R time when compared to the A-4M. Restricted access and poor visibility to attachment points, as in the AV-8A, has an even greater impact than removing one panel. Power driven actuators, generally used for heavy or large canopies, are more time consuming to work on because of their size and access requirements. Both the F-14A and F-4J require seat and canopy removal prior to replacement of the canopy actuator. These additional steps require more personnel and therefore further maintenance expenditure as seen by higher MMH/MA and MEN/MA values reported by 3-M.

Recommendations:

Mechanical assist actuators are the preferred design from the standpoint of minimizing maintenance. Where power driven actuators are used, removal of non-associated equipment should be avoided.

Ensure designs allow sufficient hand/tool room to provide a good clear view of the working area.

Avoid extensive panel removal to help minimize maintenance costs.

TABLE 6.06 MAINTENANCE DATA - SEAT ACTUATOR

WORK UNIT CODES

A-4	12111	A-6	12142	A-7	12261	AV-8	1221C	F-4	12238
F-8	N/A	F-14	1211H	P-3	N/A	S-3	N/A		

ORGANIZATIONAL LEVEL

A/C	FLIGHT HOURS	MFHBMA	MA/FH X10-3	MTTR	MMH/MA	MEN/MA	MMH/FH	R+R	O+I MTBF
A-4M	35,571	3,952.3	0.3	3.78	5.44	1.4	.001	4.38	7,114
A-6E	87,564	2,135.7	0.5	3.47	4.77	1.4	.002	4.45	3,127
A-7E	159,611	2,574.4	0.4	2.52	4.62	1.8	.002	4.17	4,837
AV-8A	19,396	19,396.0	0.1	0.30	0.30	1.0	.000		19,396
F-4J	115,070	326.9	3.1	1.80	2.84	1.6	.009	3.48	778
F-8J	18,317								
F-14A	51,286	1,046.7	1.0	2.38	4.97	2.1	.005	6.50	1,973
P-3C	125,860								
S-3A	60,552								

INTERMEDIATE LEVEL

A/C	FLIGHT HOURS	MFHBMA	MA/FH X10-3	MTTR	MMH/MA	MEN/MA	MMH/FH
A-4M	35,571	7,114.2	0.1	3.50	6.10	1.7	.001
A-6E	87,564	6,254.6	0.2	2.36	2.64	1.1	.000
A-7E	159,611	5,320.4	0.2	2.34	2.44	1.0	.000
AV-8A	19,396						
F-4J	115,070	1,027.4	1.0	2.04	2.67	1.3	.003
F-8J	18,317						
F-14A	51,286	4,662.4	0.2	1.61	2.06	1.3	.000
P-3C	125,860						
S-3A	60,552						

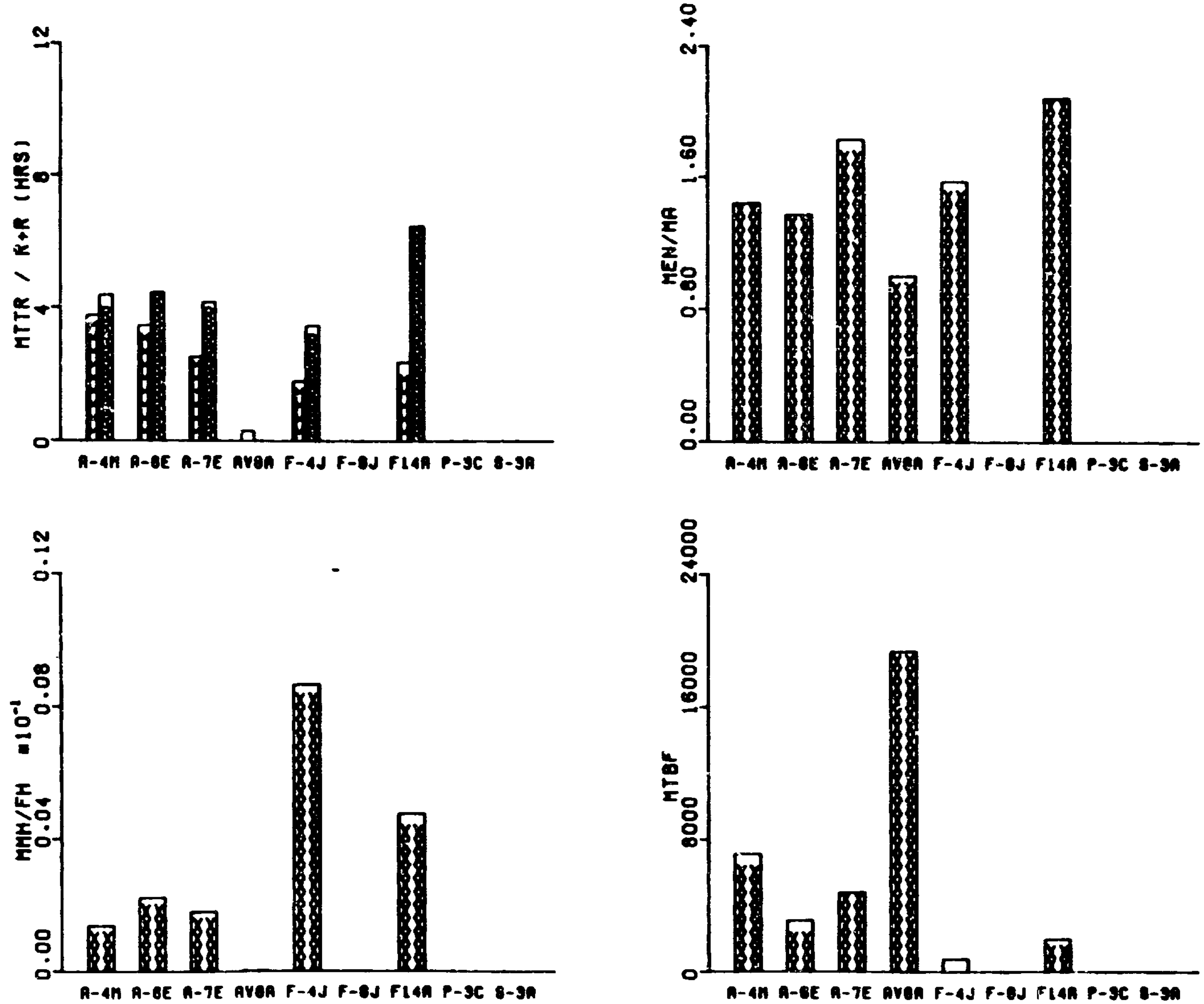


FIGURE 6.06 SELECTED GRAPHICAL DATA - SEAT ACTUATOR

6.5.6 Seat Actuator (See preceding Table and Figure 6.06)

WORK UNIT CODES

A-4 12111	A-6 12142	A-7 12261	AV-8 1221C	F-4 1223E
F-8 N/A	F-14 1211H	P-3 N/A	S-3 N/A	

DISCUSSION

Comments:

With the exception of the A-6E, all the seat actuators required ejection seat removal which in turn necessitated canopy removal. The majority of the actuators are simple to remove and the average four hour R+R time reported is due in large part to the seat removal and installation. The A-6E does not require seat removal, but maintenance savings on the seat are offset by wire splicing and motor mount/support disassembly. The high F-14A MEN/MA and R+R time is due, in part, to the requirement for accurate shimming - a time consuming process. The AV-8A had only one maintenance action in the 18 months presented, insufficient data to compare it quantitatively to the other aircraft. However, its installation is qualitatively similar to other designs requiring seat removal and could be expected also to take about 4 hours to remove and replace.

Recommendations:

Ejection seat removal should be strongly avoided. Elimination of this trait will save more time than most any other design improvement to the seat actuator.

Electrical motor connections should be by electrical connector. Splicing of wires is totally untenable.

Avoid the requirement for critical shimming of seat actuator mountings. The use of loose spacers in seat actuator installations should be avoided. Loose spacers or shims are easily dropped/lost and are awkward to use. When spacers must be utilized, employ fixed spacers (spacers permanently attached to the unit).

TABLE 6.07 MAINTENANCE DATA - BOMB BAY DOOR ACTUATOR

WORK UNIT CODES

A-4	N/A	A-6	N/A	A-7	N/A	AV-8	N/A	F-4	N/A
F-8	N/A	F-14	N/A	P-3	1152A	S-3	11211		

ORGANIZATIONAL LEVEL

A/C	FLIGHT HOURS	MFHBMA	MA/FH X10-3	MTTR	MMH/MA	MEN/MA	MMH/FH	R+R	O+I MTBF
A-4M	35,571								
A-6E	87,564								
A-7E	159,611								
AV-8A	19,396								
F-4J	115,070								
F-8J	18,317								
F-14A	51,286								
P-3C	125,860	582.7	1.7	1.91	4.03	2.1	.007	2.84	1,007
S-3A	60,552	1,100.9	0.9	2.73	5.62	2.1	.005	4.05	2,633

INTERMEDIATE LEVEL

A/C	FLIGHT HOURS	MFHBMA	MA/FH X10-3	MTTR	MMH/MA	MEN/MA	MMH/FH
A-4M	35,571						
A-6E	87,564						
A-7E	159,611						
AV-8A	19,396						
F-4J	115,070						
F-8J	18,317						
F-14A	51,286						
P-3C	125,860	1,324.8	0.8	4.00	5.77	1.4	.004
S-3A	60,552	3,784.5	0.3	1.44	1.81	1.3	.000

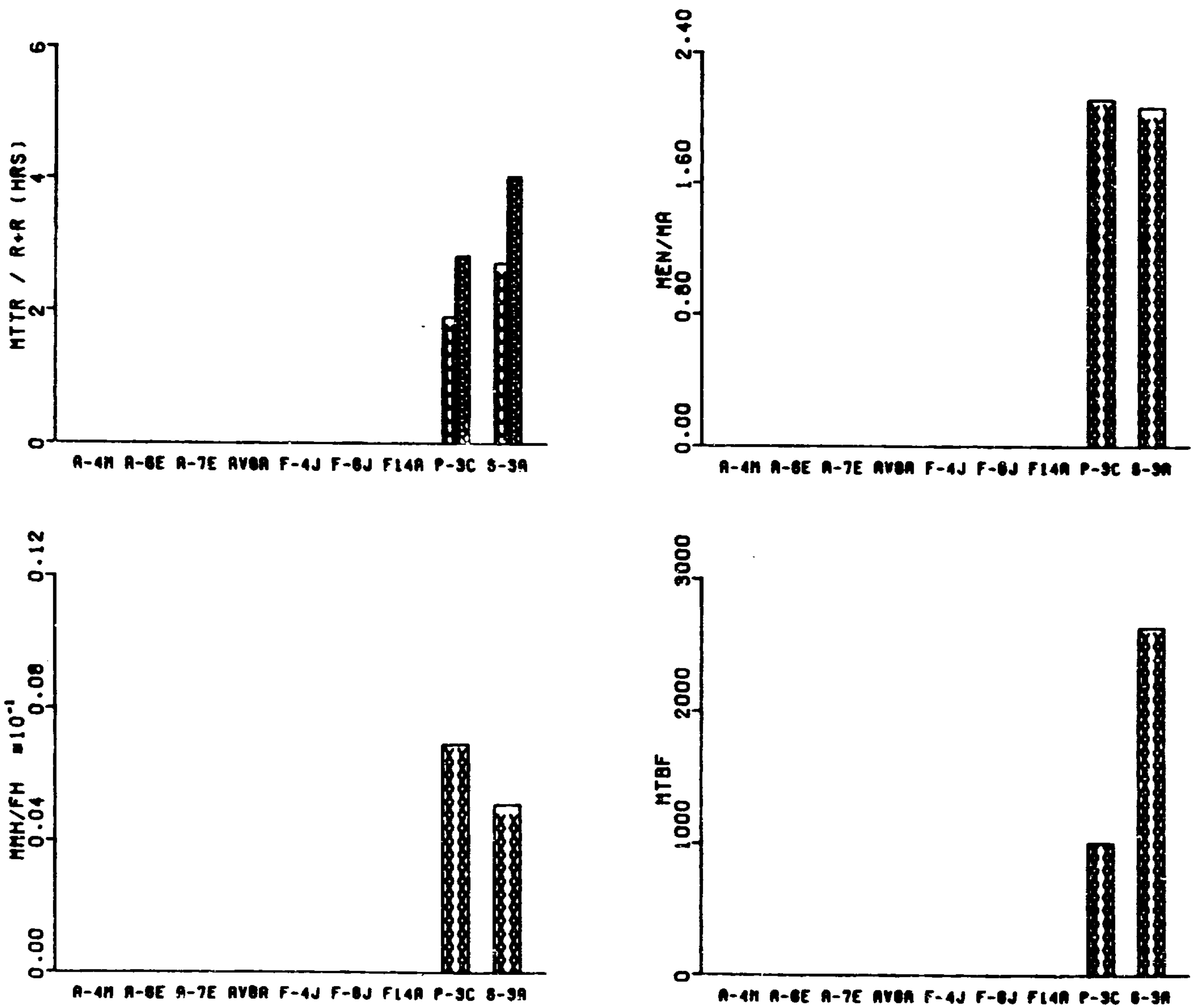


FIGURE 6.07 SELECTED GRAPHICAL DATA - BOMB BAY DOOR ACTUATOR

6.5.7 Bomb Bay Door Actuator (See preceding Table and Figure 6.07)

WORK UNIT CODES

A-4 N/A	A-6 N/A	A-7 N/A	AV-8 N/A	F-4 N/A
F-8 N/A	F-14 N/A	P-3 1152A	S-3 11211	

DISCUSSION

Comments:

The quantitative data presented herein belies the qualitative installation data elaborated in Reference 21. Both bomb bay door actuator installations are straightforward and simple. The amount of attachment hardware requiring disassembly in both designs is minimized. The S-3A uses a spring loaded spline connector which further facilitates maintenance. Since the removals and installations of the two actuators are essentially the same, the S-3A's significantly higher maintenance rates can only be attributed either more cramped working conditions created by the belly location of the actuator, a more lengthy operational check, or the use of High-Torque mounting bolts and panel screws (these screws wallow out and frequently need to be drilled out).

Recommendations:

Where splines are used to drive motors or flexible shafts in door operations, use of the S-3A type spring loaded connector is desirable.

As with any belly installation on a low profile aircraft, more time is needed to perform an action. Unless necessary or unavoidable, locate components off the belly centerline.

TABLE 6.08 MAINTENANCE DATA - MLG WHEEL AND TIRE

WORK UNIT CODES

A-4	13143	A-6	13511	A-7	13131	AV-8	13511	F-4	13251
F-8	13411	F-14	13511	P-3	1343A	S-3	13531		

ORGANIZATIONAL LEVEL

A/C	FLIGHT HOURS	MFHBMA	MA/FH X10-3	MTTR	MMH/MA	MEN/MA	MMH/FH	R+R	O+I MTBF
A-4M	35,571	16.8	59.4	0.91	1.74	1.9	.104	0.84	326
A-6E	87,564	55.1	18.1	1.13	2.14	1.9	.039	1.10	187
A-7E	159,611	28.9	34.6	1.06	1.69	1.8	.065	0.99	189
AV-8A	19,396	28.1	35.6	0.94	1.74	1.9	.062	0.89	209
F-4J	115,070	18.6	53.7	0.86	1.36	1.6	.073	0.63	73
F-8J	18,317	12.4	80.5	0.84	1.44	1.7	.116	0.90	51
F-14A	51,286	27.5	36.4	0.98	1.84	1.9	.067	1.00	78
P-3C	125,860	39.0	25.6	1.21	2.79	2.3	.072	1.27	554
S-3A	60,552	19.5	51.4	0.87	1.48	1.7	.076	0.78	222

INTERMEDIATE LEVEL

A/C	FLIGHT HOURS	MFHBMA	MA/FH X10-3	MTTR	MMH/MA	MEN/MA	MMH/FH
A-4M	35,571	15.9	63.0	1.91	3.54	1.9	.223
A-6E	87,564	53.3	18.8	2.18	3.69	1.7	.069
A-7E	159,611	31.1	32.1	1.69	2.78	1.6	.089
AV-8A	19,396	25.8	38.7	2.01	3.80	1.9	.147
F-4J	115,070	17.0	58.8	2.20	3.97	1.8	.234
F-8J	18,317	12.3	81.1	1.34	2.66	2.0	.216
F-14A	51,286	26.1	38.3	2.38	4.26	1.8	.163
P-3C	125,860	44.3	22.6	2.54	3.83	1.5	.087
S-3A	60,552	25.9	38.6	2.96	3.96	1.3	.153

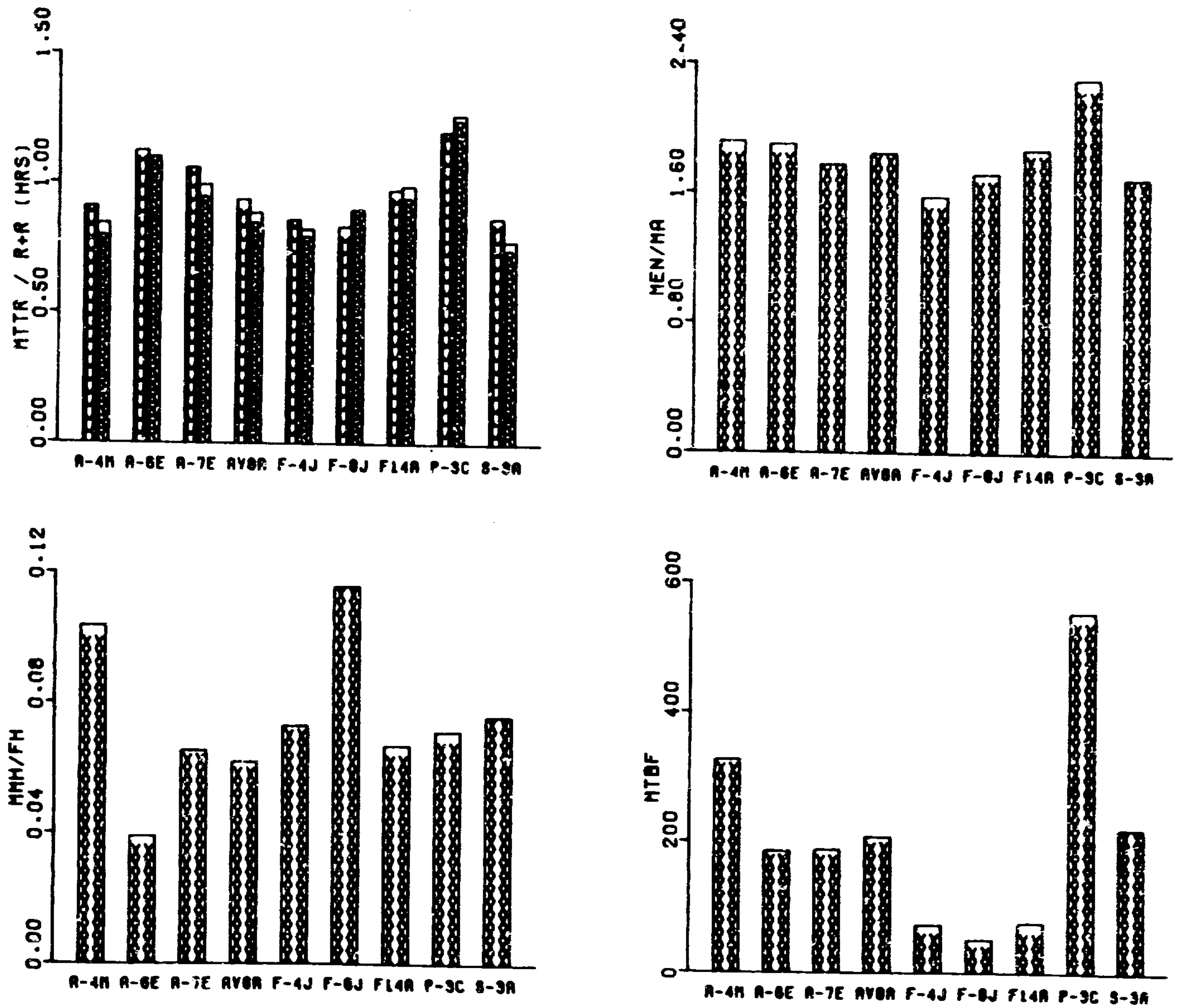


FIGURE 6.08 SELECTED GRAPHICAL DATA - MLO WHEEL AND TIRE

6.8 LANDING GEAR SYSTEM

6.8.1 Main Landing Gear (MLG) Wheel and Tire (See preceding Table and Figure 6.08)

WORK UNIT CODES

A-4 13143	A-6 13511	A-7 13131	AV-8 13511	F-4 13251
F-8 13411	F-14 13511	P-3 1343A	S-3 13531	

DISCUSSION

Comments:

Qualitatively, the design of the main wheel and tire assemblies is essentially the same for all aircraft surveyed. This is further borne out in the quantitative numbers as all aircraft exhibited about the same maintenance rates. Each installation has some minor weaknesses and some strong points which tend to cancel each other out when viewed solely from maintenance experience reported in 3-M. The P-3C maintenance parameters are the highest in all categories analyzed and this is primarily due to the physical size of the tire. The low R+R time registered by the S-3A can be partly attributed to a special bolt, which when tightened, keeps the brake discs aligned while the tire is off. This feature eliminates one of the time consuming installation steps - brake disc alignment. The F-4J and AV-8A utilize the parking brake to accomplish the same function but some time savings are lost as the parking brake is located in a different work area. Slightly higher than average maintenance is recorded for the A-6E and A-7E and is due primarily to some difficulty in aligning brake discs.

Recommendations:

Automatic retention of the brake discs in their aligned position while the tire is off should be a substantial cost saving feature. Less preferred would be use of a special tool, as used on the P-3C and F-4J, to maintain alignment.

Require the interchangeability of left and right-hand tires by adding any peculiar components such as speed sensor discs to all tires to reduce "Murphyism" and spares.

Maintenance of wheel bearings should be divorced from wheel and tire replacement. Utilizing designs such as the F-14 false axle prevents bearing damage, contamination, and ensures proper lubrication as lubricating can be done in a shop environment rather in the field.

Avoid requiring personnel to perform maintenance in two different work areas as this either requires an extra person or breaks up the continuity of the task.

Incorporation of speed and anti-skid equipment in the axle eliminates maintenance and adjustments to these systems during frequent unscheduled tire replacements.

Incorporate two sets of lock bolt holes in the axle to facilitate installations whose axle nuts require torquing.

TABLE 6.09 MAINTENANCE DATA - NLG WHEEL AND TIRE

WORK UNIT CODES

A-4	13233	A-6	13512	A-7	13161	AV-8	13521	F-4	13331
F-8	13412	F-14	13521	P-3	13238	S-3	13231		

ORGANIZATIONAL LEVEL

A/C	FLIGHT HOURS	MFHBMA	MA/FH X10-3	MTTR	MMH/MA	MEN/MA	MMH/FH	R+R	O+I MTBF
A-4M	35,571	49.3	20.3	0.95	1.72	1.8	.035	0.96	671
A-6E	87,564	53.4	18.7	0.99	1.86	1.9	.035	0.93	192
A-7E	159,611	84.5	11.8	0.99	1.68	1.7	.020	0.89	500
AV-8A	19,396	52.9	18.9	0.96	1.84	1.9	.035	0.88	396
F-4J	115,070	18.5	54.0	0.73	1.07	1.4	.058	0.73	112
F-8J	18,317	78.3	12.8	0.86	1.42	1.6	.018	0.91	382
F-14A	51,286	40.9	24.5	0.80	1.39	1.7	.034	0.71	128
P-3C	125,860	86.5	11.6	1.14	2.41	2.1	.028	1.13	707
S-3A	60,552	47.8	20.9	0.87	1.48	1.7	.031	0.84	531

INTERMEDIATE LEVEL

A/C	FLIGHT HOURS	MFHBMA	MA/FH X10-3	MTTR	MMH/MA	MEN/MA	MMH/FH
A-4M	35,571	46.8	21.4	1.65	3.29	2.0	.070
A-6E	87,564	53.1	18.8	1.92	3.30	1.7	.062
A-7E	159,611	91.8	10.9	1.23	1.87	1.5	.020
AV-8A	19,396	49.5	20.2	1.85	3.64	2.0	.074
F-4J	115,070	17.4	57.4	1.82	3.20	1.8	.184
F-8J	18,317	80.0	12.5	0.85	1.62	1.9	.020
F-14A	51,286	40.7	24.6	2.17	3.41	1.6	.084
P-3C	125,860	94.3	10.6	1.85	2.90	1.6	.031
S-3A	60,552	62.9	15.9	2.52	3.20	1.3	.051

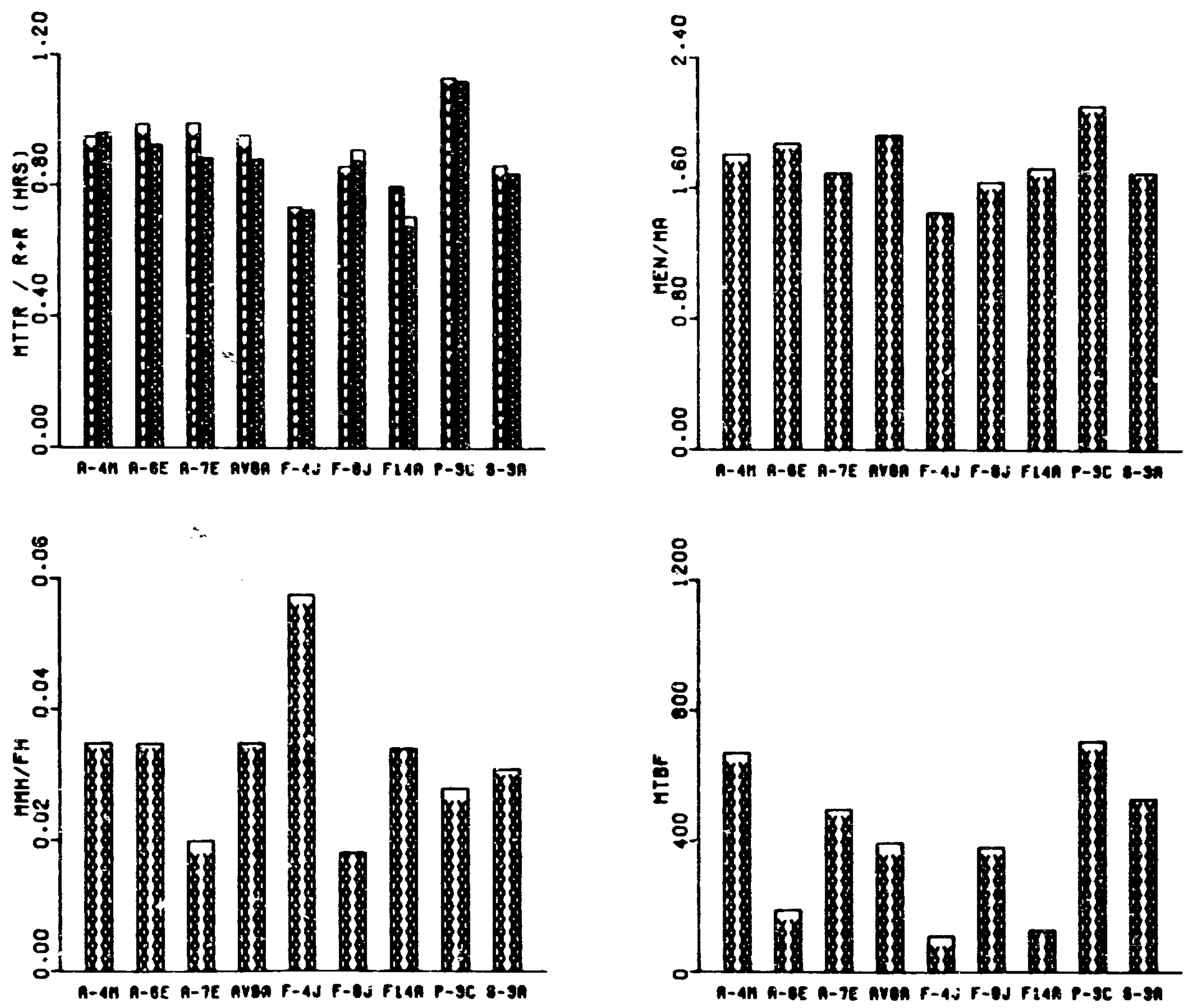


FIGURE 6.09 SELECTED GRAPHICAL DATA - NLG WHEEL AND TIRE

6.6.2 Nose Landing Gear (NLG) Wheel and Tire (See preceding Table and Figure 6.09)

WORK UNIT CODES

A-4 13233	A-6 13512	A-7 13161	AV-8 13521	F-4 13331
F-8 13412	F-14 13521	P-3 13238	S-3 13231	

DISCUSSION

Comments:

Like the main landing gear, nose landing gear wheel and tire assemblies are almost identical in their installation design. Data from the 3-M system bears this out as the majority fall within a narrow band of MTTR and R+R time. All aircraft except the F-14A use an axle lock bolt to ensure the tire assembly is safely retained. The F-14's false axle, instead of an axle bolt, has enabled maintenance personnel to perform the wheel and tire assembly installation in less time than most of the other airplanes. Physical size of the P-3C wheel and tire assembly was the leading cause for the maintenance rates being much higher than the remaining air vehicles. The A-4M needs more R+R time because a tail jack must be positioned before the nose is jacked to prevent shifting of the aircraft center of gravity.

Recommendations:

If possible eliminate the need for a lock bolt. The F-14A has shown elimination of lock bolts is cost effective. When lock bolts must be used, ensure two sets of holes are provided in the axle to facilitate bolt insertion after torquing the axle nut.

Most designs include the wheel bearings as part of the tire assembly. This practice should be continued as it prevents bearing damage, contamination, and ensures proper lubrication.

TABLE 6.10 MAINTENANCE DATA - MLG WHEEL BRAKE

WORK UNIT CODES

A-4	13716	A-6	13611	A-7	13511	AV-8	13716	F-4	13440
F-8	13511	F-14	13811	P-3	13520	S-3	13611		

ORGANIZATIONAL LEVEL

A/C	FLIGHT HOURS	MFHBMA	MA/FH X10-3	MTTR	MMH/MA	MEN/MA	MMH/FH	R+R	O+I MTBF
A-4M	35,571	51.3	19.5	1.32	2.61	2.0	.051	2.04	62
A-6E	87,564	153.6	6.5	2.08	4.55	2.2	.030	2.33	212
A-7E	159,611	152.6	6.6	1.71	3.38	2.0	.022	1.96	240
AV-8A	19,396	197.9	5.1	2.94	5.57	1.9	.028	3.42	259
F-4J	115,070	106.4	9.4	3.06	6.24	2.0	.059	2.95	143
F-8J	18,317	32.3	31.0	1.13	2.02	1.8	.062	1.29	40
F-14A	51,286	37.6	26.8	1.41	3.11	2.2	.083	1.69	92
P-3C	125,860	176.8	5.7	2.07	5.30	2.6	.030	2.90	128
S-3A	60,552	56.0	17.9	1.54	3.03	2.0	.054	1.90	173

INTERMEDIATE LEVEL

A/C	FLIGHT HOURS	MFHBMA	MA/FH X10-3	MTTR	MMH/MA	MEN/MA	MMH/FH
A-4M	35,571	223.7	4.5	4.19	6.25	1.5	.028
A-6E	87,564	200.4	5.0	5.65	7.14	1.3	.036
A-7E	159,611	238.6	4.2	5.08	6.25	1.2	.026
AV-8A	19,396	200.0	5.0	3.64	6.89	1.9	.034
F-4J	115,070	139.8	7.2	6.89	8.46	1.2	.060
F-8J	18,317	41.3	24.2	4.58	4.98	1.1	.121
F-14A	51,286	97.7	10.2	0.91	1.09	1.2	.011
P-3C	125,860	131.0	7.6	3.68	5.16	1.4	.039
S-3A	60,552	163.7	6.1	4.51	6.63	1.5	.041

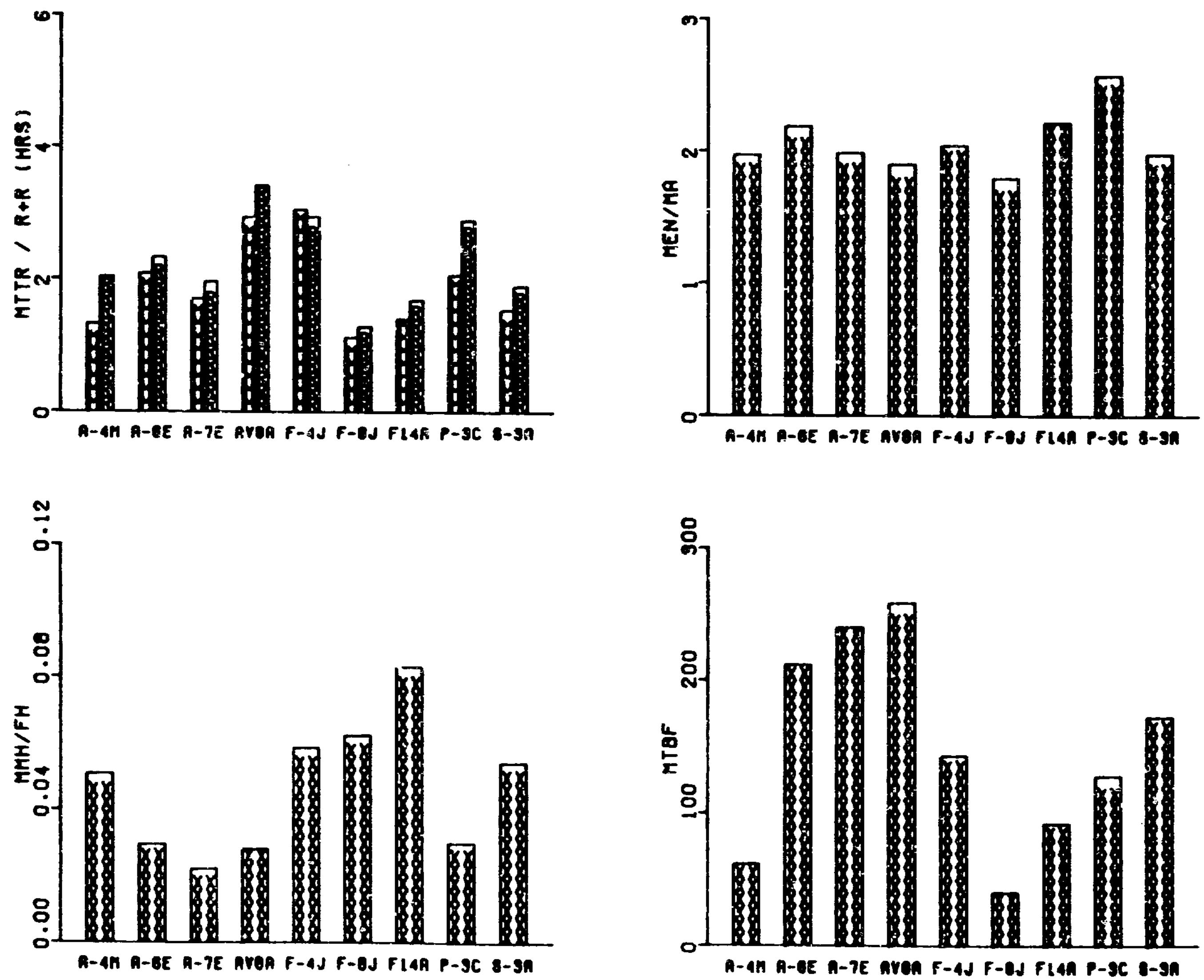


FIGURE 6.10 SELECTED GRAPHICAL DATA - MLO WHEEL BRAKE

6.6.3 Main Landing Gear (MLG) Wheel Brake (See preceding Table and Figure 6.10)

WORK UNIT CODES

A-4 13716	A-6 13611	A-7 13511	AV-8 13716	F-4 13440
F-8 13511	F-14 13811	P-3 1352D	S-3 13611	

DISCUSSION

Comments:

In general brake disc alignment prior to reinstalling the wheel and tire assembly has had a marked effect on R+R times. Alignment is time consuming in many cases, especially on the AV-8A. The F-8J recorded the lowest maintenance parameters for a bolted on assembly, which is fortunate because of its low MTBF. Use of a single bolt to attach the brake to the shock strut has kept the S-3A and A-7E replacement times low. The A-4M brakes bleed without need of external hydraulic power thereby saving some maintenance expenditure. The F-14A uses a ball lock pin to hold the brake onto the landing gear assembly. This facilitates maintenance and contributes toward the F-14A's low R+R time. Use of shims and sealant in F-4J installation has added to the maintenance effort on replacement.

Recommendations:

Beryllium drastically cuts the weight of a brake assembly, but the dust is hazardous to health and compromises otherwise good maintainability features.

Avoid having to remove shuttle valves and antiskid components as this unnecessarily complicates the job. These components should either be part of the brake or shock strut and should only require that lines be disconnected.

Eliminate the need for time consuming disc alignment. Make the discs self-aligning or, less perferable, provide a tool to ease the alignment (F-4J and P-3C have such a tool).

Brake bleeding without need of external hydraulic power is a feature worth incorporating.

TABLE 6.11 MAINTENANCE DATA - MLG SHOCK STRUT

WORK UNIT CODES

A-4	13121	A-6	13111	A-7	13121	AV-8	13111	F-4	13211
F-8	13121	F-14	13111	P-3	13411	S-3	13511		

ORGANIZATIONAL LEVEL

A/C	FLIGHT HOURS	MFHBMA	MA/FH X10-3	MTTR	MMH/MA	MEN/MA	MMH/FH	R+R	O+I MTBF
A-4M	35,571	259.6	3.9	2.24	5.25	2.3	.020	6.32	349
A-6E	87,564	243.9	4.1	2.49	5.61	2.2	.023	20.07	307
A-7E	159,611	211.1	4.7	2.68	6.42	2.4	.030	4.59	321
AV-8A	19,396	554.2	1.8	4.73	12.06	2.5	.022	25.20	647
F-4J	115,070	140.0	7.1	6.60	18.27	2.8	.130	19.28	182
F-8J	18,317	122.1	8.2	2.39	5.71	2.4	.047	3.36	197
F-14A	51,286	339.6	2.9	2.90	7.85	2.7	.023	17.63	564
P-3C	125,860	210.8	4.7	1.82	4.10	2.3	.019	10.33	310
S-3A	60,552	582.2	1.7	2.17	5.31	2.4	.009	7.41	797

INTERMEDIATE LEVEL

A/C	FLIGHT HOURS	MFHBMA	MA/FH X10-3	MTTR	MMH/MA	MEN/MA	MMH/FH
A-4M	35,571	1,872.2	0.5	6.13	7.41	1.2	.004
A-6E	87,564	12,509.1	0.1	1.89	2.10	1.1	.000
A-7E	159,611	1,116.2	0.9	2.97	3.84	1.3	.003
AV-8A	19,396	4,849.0	0.2	0.38	0.88	2.3	.000
F-4J	115,070	983.5	1.0	1.78	3.06	1.7	.003
F-8J	18,317	523.3	1.9	8.21	12.59	1.5	.024
F-14A	51,286						
P-3C	125,860	20,976.7	0.0	6.00	20.75	3.5	.001
S-3A	60,552	10,092.0	0.1	5.73	8.78	1.5	.001

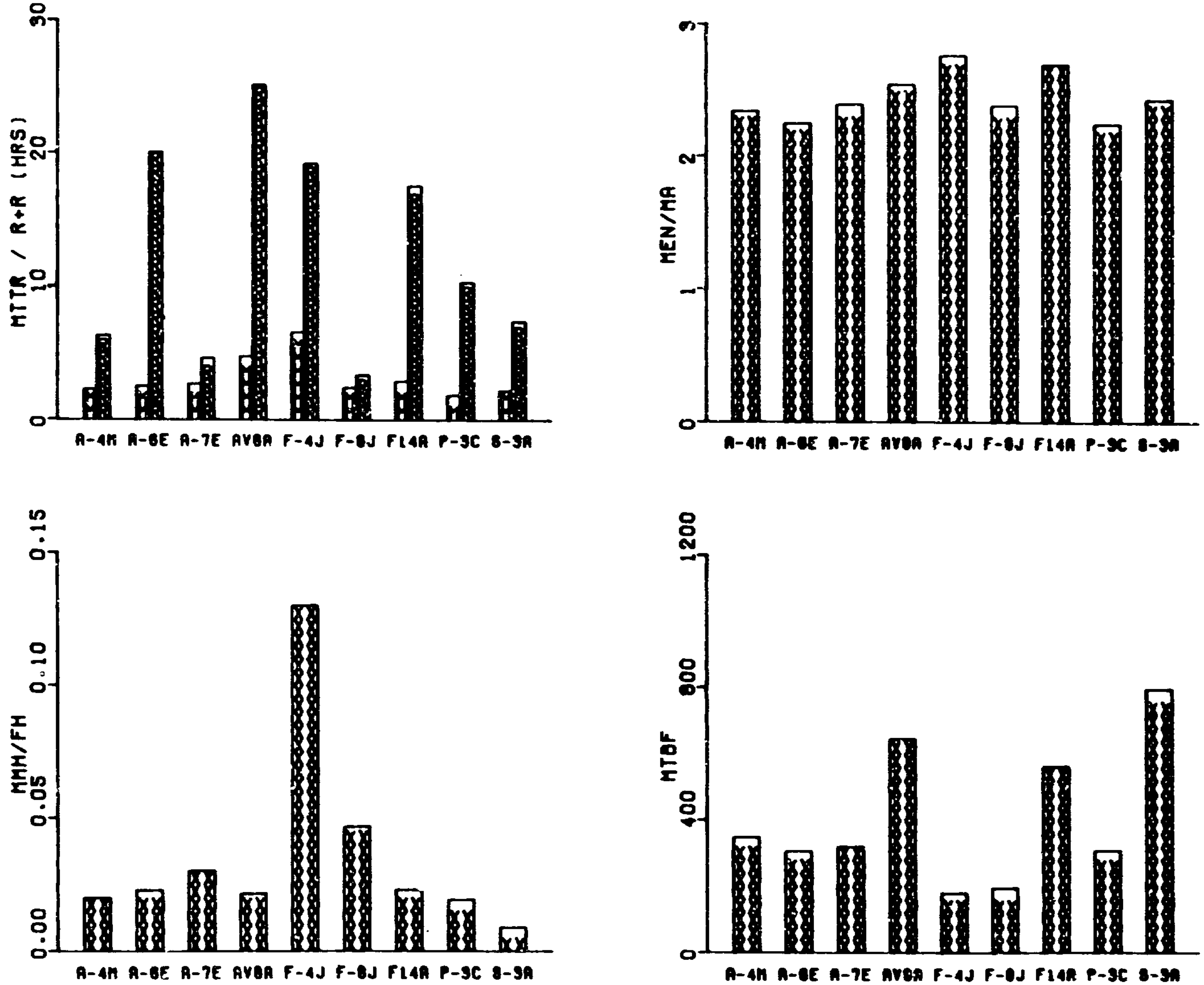


FIGURE 6.11 SELECTED GRAPHICAL DATA - MLG SHOCK STRUT

6.6.4 Main Landing Gear (MLG) Shock Strut (See preceding Table and Figure 6.11)

WORK UNIT CODES

A-4 13121	A-6 13111	A-7 13121	AV-8 13111	F-4 13211
F-8 13121	F-14 13111	P-3 13411	S-3 13511	

DISCUSSION

Comments:

Installations utilizing a tripod type main landing gear design are by far less costly to maintain. The use of the tripod style gear allows for removal of only the shock strut portion. Wheels and tires stay on the aircraft and the tripod gear allows the shock strut to be smaller and lighter. The A-7E, F-8J, and S-3A employ this design. The S-3A requires slightly more time than the other tripod designs due to its larger size and the corrosion protection procedures required on its trunnion assembly. The saddle bolt arrangement of the P-3C shock strut generates substantial time savings considering the size of the component. The strong feature of external access to the trunnion bolt on the AV-8A does not compensate for the cramped working quarters and the awkwardness of the tandem strut. The need for accurate shimming on the F-4J adds to R+R time.

Recommendations:

Require as little shock strut build-up as possible during installation. Utilize clamps to hold hydraulic lines (as in F-14A). When hydraulic swivels are used they should be part of the strut or airplane to avoid loosening or removing multitude of hydraulic connections.

Avoid partial shock strut movement as part of the removal procedure. Provisions for a separate external hydraulic service panel instead of disturbing engine accesses and hoses is recommended.

Avoid the requirement for critical shimming in shock strut installations.

Do not block attach bolts and fittings with hydraulic, electrical or pneumatic lines.

TABLE 6.12 MAINTENANCE DATA - NLG SHOCK STRUT

WORK UNIT CODES

A-4	13221	A-6	13211	A-7	13151	AV-8	13216	F-4	13313
F-8	13221	F-14	13311	P-3	13211	S-3	13211		

ORGANIZATIONAL LEVEL

A/C	FLIGHT HOURS	MFHBMA	MA/FH X10-3	MTTR	MMH/MA	MEN/MA	MMH/FH	R+R	O+I MTBF
A-4M	35,571	263.5	3.8	1.49	2.97	2.0	.011	6.17	345
A-6E	87,564	298.9	3.3	4.14	11.18	2.7	.037	14.76	413
A-7E	159,611	257.4	3.9	5.73	15.07	2.6	.059	9.75	568
AV-8A	19,396	200.0	5.0	1.82	4.12	2.3	.021	5.35	246
F-4J	115,070	500.3	2.0	4.68	12.57	2.7	.025	16.73	661
F-8J	18,317	91.6	10.9	2.62	6.15	2.3	.067	8.67	130
F-14A	51,286	249.0	4.0	2.78	8.02	2.9	.032	10.62	398
P-3C	125,860	451.1	2.2	2.15	5.02	2.3	.011	19.33	572
S-3A	60,552	931.6	1.1	3.60	11.60	3.2	.012	19.90	1,442

INTERMEDIATE LEVEL

A/C	FLIGHT HOURS	MFHBMA	MA/FH X10-3	MTTR	MMH/MA	MEN/MA	MMH/FH
A-4M	35,571	8,892.8	0.1	10.28	16.75	1.6	.002
A-6E	87,564	4,864.7	0.2	4.23	6.09	1.4	.001
A-7E	159,611	760.1	1.3	0.23	0.37	1.6	.000
AV-8A	19,396	1,140.9	0.9	1.52	2.20	1.4	.002
F-4J	115,070	3,967.9	0.3	3.18	5.20	1.6	.001
F-8J	18,317	763.2	1.3	3.42	5.08	1.5	.007
F-14A	51,286	7,326.6	0.1	3.50	3.79	1.1	.001
P-3C	125,860	41,953.3	0.0	1.00	1.67	1.7	.000
S-3A	60,552	30,276.0	0.0	1.25	2.50	2.0	.000

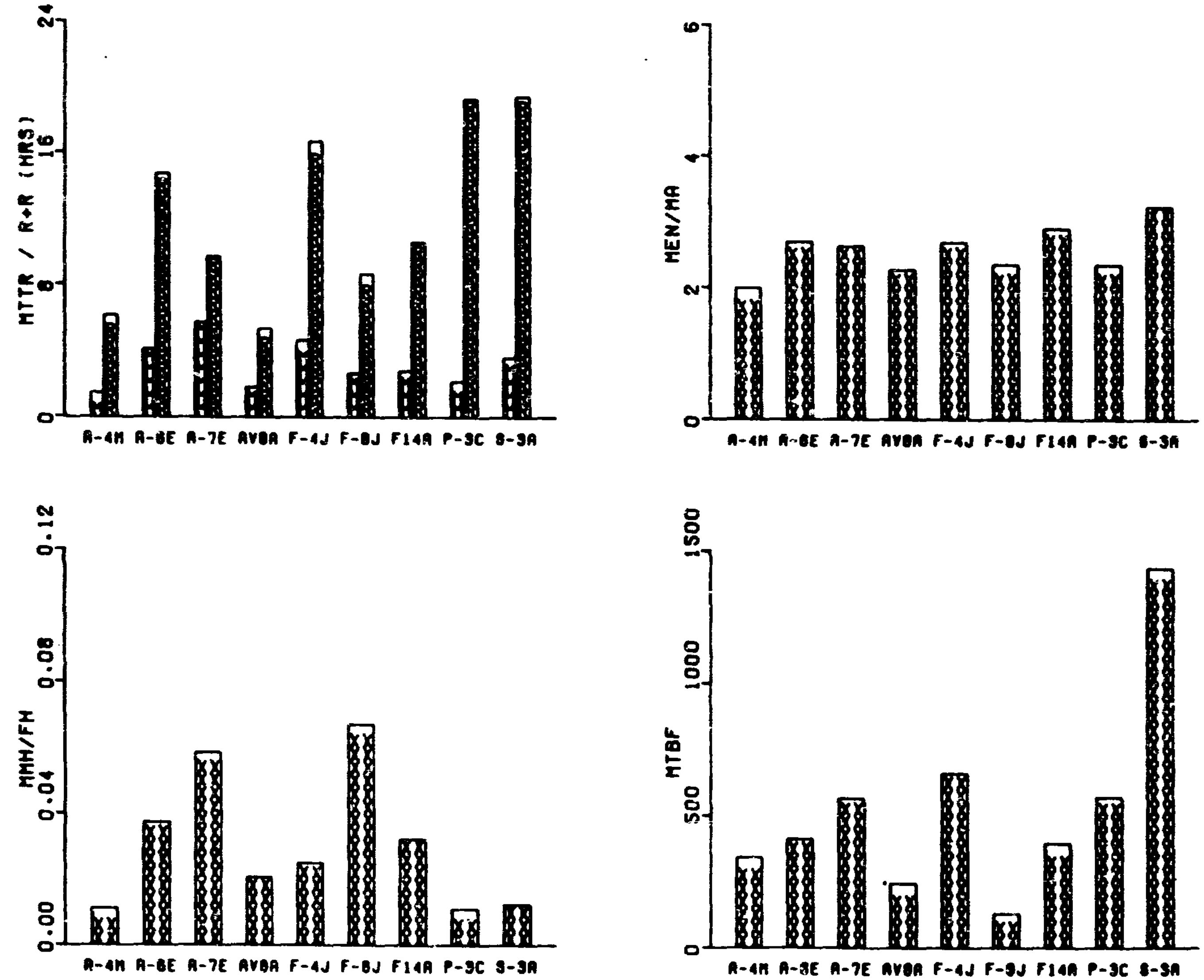


FIGURE 6.12 SELECTED GRAPHICAL DATA - NLG SHOCK STRUT

6.6.5 Nose Landing Gear (NLG) Shock Strut (See preceding Table and Figure 6.12)

WORK UNIT CODES

A-4 13221	A-6 13211	A-7 13151	AV-8 13216	F-4 13313
F-8 13221	F-14 13311	P-3 13211	S-3 13211	

DISCUSSION

Comments:

The qualitative analysis of the nose landing gear shock struts appears not to agree with the quantitative values presented herein. One of the best nose landing gear shock strut installations qualitatively also has experienced one of the highest R+R times of the nine aircraft surveyed. The P-3C is characterized by a clear wheel well, a minimum of disassembly, and an effective handling dolly. Although its size and weight must add to the amount of time and the number of personnel required, the shock strut was removed only three times making its R+R time suspect as a valid average. Some of the excess time in those three removals may be associated with personnel needing to review technical data before, during, and after the task because shock strut replacement now becomes a unique action and not routine. Similarly, the S-3A shock strut has been infrequently removed and R+R time experienced may reflect learning curves. In a more crowded wheel well than the P-3C, the S-3A design allows the axle beam to be removed from the shock strut without removing the wheels and tires - a maintenance time saver. The A-4M R+R times must be considered statistically invalid as it also is derived from three remove and replace actions. Qualitatively, the A-4M installation is one of the least desirable with cramped workspace and trunnion bolts which are difficult to remove. The design of the AV-8A steering cylinder, which is integral with the shock strut, and the lack of a launch bar, because of its V/STOL operational mode, combine to simplify maintenance on its nose shock strut. This can be seen in the 3-M data as the AV-8A exhibits some of the lowest maintenance parameters experienced by the surveyed airplanes.

Recommendations:

Avoid the need for a test set when replacing the nose steering unit.

Eliminate requirements for partial shock strut retraction upon removal and ensure attach bolts and fittings are not blocked by hydraulic lines.

Use clamping devices which maintain electrical and hydraulic line routing to ease on-aircraft build-up.

Eliminate or minimize special tools needed to disconnect linkages or remove trunnion bolts. When it is suspected that working room on trunnion bolts may be insufficient to expeditiously accomplish removal or replacement, consider design changes which provide for access to trunnion bolts through the side of the fuselage.

Utilize quick disconnects, e.g. pip pins, on linkages and steering units to reduce maintenance time.

TABLE 6.13 MAINTENANCE DATA - NOSE WHEEL STEERING UNIT

WORK UNIT CODES

A-4	N/A	A-6	13724	A-7	13612	AV-8	N/A	F-4	13342
F-8	13311	F-14	13921	P-3	13322	S-3	13311		

ORGANIZATIONAL LEVEL

A/C	FLIGHT HOURS	MFHBMA	MA/FH X10-3	MTTR	MMH/MA	MEN/MA	MMH/FH	R+R	O+I MTBF
A-4M	35,571								
A-6E	87,564	509.1	2.0	2.92	6.41	2.2	.013	4.18	1,510
A-7E	159,611	273.3	3.7	3.07	6.11	2.0	.022	5.35	691
AV-8A	19,396								
F-4J	115,070	460.3	2.2	3.79	7.33	1.9	.016	4.67	852
F-8J	18,317	654.2	1.5	10.59	26.46	2.5	.040	16.06	872
F-14A	51,286	171.5	5.8	3.73	10.16	2.7	.059	6.47	513
P-3C	125,860	2,568.6	0.4	2.14	4.38	2.0	.002	4.09	4,195
S-3A	60,552	106.8	9.4	3.61	7.35	2.0	.069	8.11	237

INTERMEDIATE LEVEL

A/C	FLIGHT HOURS	MFHBMA	MA/FH X10-3	MTTR	MMH/MA	MEN/MA	MMH/FH
A-4M	35,571						
A-6E	87,564	2,575.4	0.4	1.57	1.60	1.0	.001
A-7E	159,611	818.5	1.2	4.28	5.47	1.3	.007
AV-8A	19,396						
F-4J	115,070	1,055.7	0.9	2.97	3.40	1.1	.003
F-8J	18,317	1,077.5	0.9	2.89	2.89	1.0	.003
F-14A	51,286	827.2	1.2	0.56	0.61	1.1	.001
P-3C	125,860	9,681.5	0.1	2.73	4.23	1.5	.000
S-3A	60,552	1,044.0	1.0	0.97	1.18	1.2	.001

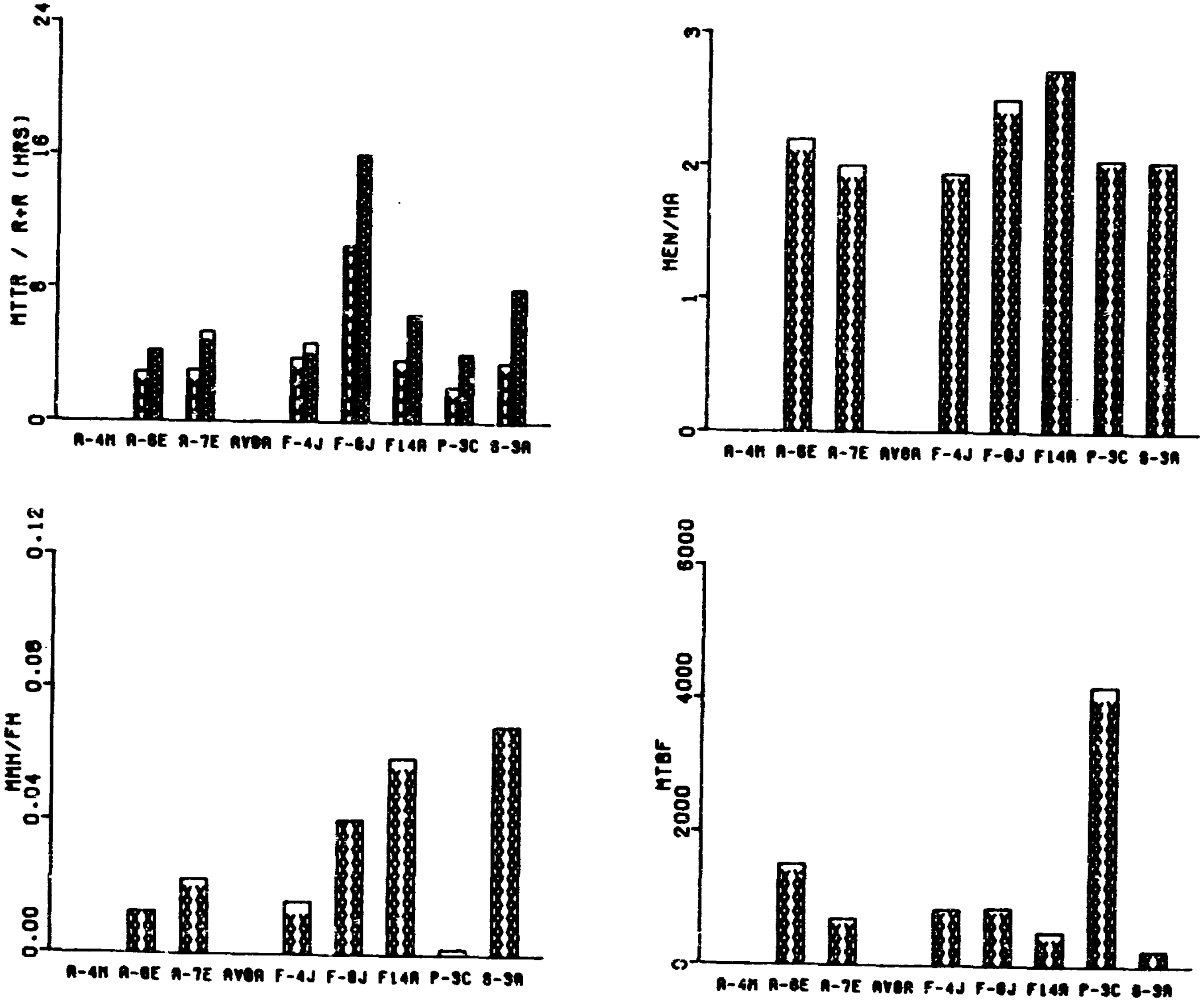


FIGURE 6.13 SELECTED GRAPHICAL DATA - NOSE WHEEL STEERING UNIT

6.6.6 Nose Wheel Steering Unit (See preceding Table and Figure 6.13)

WORK UNIT CODES

A-4 N/A	A-6 13724	A-7 13612	AV-8 N/A	F-4 13342
F-8 13311	F-14 13921	P-3 13322	S-3 13311	

DISCUSSION

Comments:

Quantitatively the worst nose wheel steering unit installation is also the worst qualitatively. Replacement of the F-8J steering unit requires the nose landing gear shock strut be removed. This design situation is unacceptable. The remainder of the aircraft quantitatively match their qualitative features. Most use a geared steering mechanism and employ a rig pin index feature on installation to simplify or eliminate rigging. The A-7E does not use a rig pin index feature and consequently requires longer to replace. The S-3A quantitative data shows the effect of the difficulty induced by the combination of cramped work space and heavy cylinder weight when inserting the mounting bolt. The smallness of the P-3C actuator enabled maintenance to be performed more quickly. The P-3C is a wire rope instead of gear actuated system.

Recommendations:

Use an index pin system when installing the steering cylinder to eliminate the need for rigging.

Avoid the use of complex linkages in designs. Utilize flexible hoses or tubes rather than brazed tubes for hydraulic lines to the reduce potential for hydraulic line damage.

Designers should "steer away" from attaching unassociated equipment, e.g. hydraulic lines or electrical conduits, to this component.

TABLE 6.14 MAINTENANCE DATA - ARRESTING HOOK ASSEMBLY

WORK UNIT CODES

A-4	1382J	A-6	13811	A-7	13810	AV-8	N/A	F-4	13520
F-8	13811	F-14	13A15	P-3	N/A	S-3	13710		

ORGANIZATIONAL LEVEL

A/C	FLIGHT HOURS	MFHBMA	MA/FH X10-3	MTTR	MMH/MA	MEN/MA	MMH/FH	R+R	O+I MTBF
A-4M	35,571	635.2	1.6	1.82	3.12	1.7	.005	1.34	1,112
A-6E	87,564	149.4	6.7	1.62	3.17	2.0	.021	1.91	456
A-7E	159,611	73.6	13.6	1.21	2.23	1.8	.030	1.96	206
AV-8A	19,396								
F-4J	115,070	84.9	11.8	3.01	6.30	2.1	.074	6.04	185
F-8J	18,317	796.4	1.3	8.57	18.51	2.2	.023	10.07	1,832
F-14A	51,286	335.2	3.0	2.38	6.02	2.5	.018	2.74	1,115
P-3C	125,860								
S-3A	60,552	76.6	13.1	1.01	1.95	1.9	.025	1.24	300

INTERMEDIATE LEVEL

A/C	FLIGHT HOURS	MFHBMA	MA/FH X10-3	MTTR	MMH/MA	MEN/MA	MMH/FH
A-4M	35,571	3,952.3	0.3	1.42	1.42	1.0	.000
A-6E	87,564	411.1	2.4	0.39	0.50	1.3	.001
A-7E	159,611	387.4	2.6	0.19	0.28	1.5	.001
AV-8A	19,396						
F-4J	115,070	313.5	3.2	0.45	0.65	1.4	.002
F-8J	18,317	915.9	1.1	0.41	0.48	1.2	.001
F-14A	51,286	596.3	1.7	0.47	0.51	1.1	.001
P-3C	125,860						
S-3A	60,552	582.2	1.7	0.34	0.36	1.1	.001

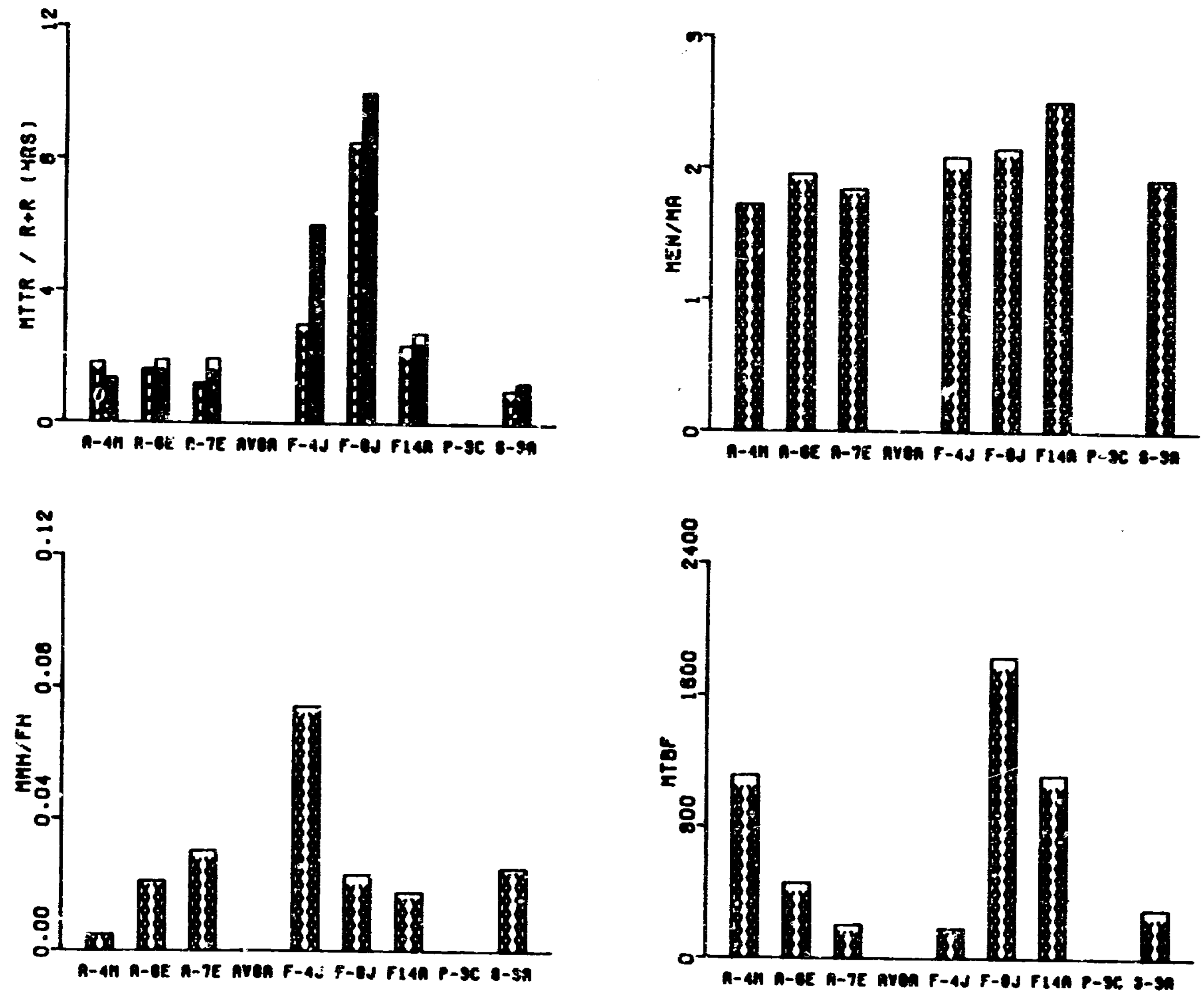


FIGURE 6.14 SELECTED GRAPHICAL DATA - ARRESTING HOOK ASSEMBLY

6.6.7 Arresting Hook Assembly (See preceding Table and Figure 6.14)

WORK UNIT CODES

A-4 13820	A-6 13811	A-7 13810	AV-8 N/A	F-4 13520
F-8 13811	F-14 13A15	P-3 N/A	S-3 13710	

DISCUSSION

Comments:

Comparison of qualitative features and quantitative numbers indicates that concealing arresting gear hook shank attachment points behind panels with large quantities of panel fasteners has the greatest adverse effect on maintenance. The F-4J, F-8J, and F-14A all require removing panels with many screws. Panel removal is not at fault, but rather, the time is impacted by the quantity and type of fasteners used to secure the panel. Jacking requirements for the A-4M and A-7E seem to have little effect on R+R time. The S-3A shank separates from the drag brace assembly in open view while supported on an adapter; thereby optimizing all of its quantitative parameters. The high R+R for the F-8J is due in part to many panel fasteners, cramped spaces under the airplane, and insufficient tool and hand room.

Recommendations:

Eliminate access panel removal requirements when possible. When access panels must be used, use as few panel fasteners as structurally feasible, and those which are used, should be quick release type.

Location of arresting gear hook assemblies necessitates cramped, under airplane working areas. However, avoid aircraft jacking when possible because it unnecessarily adds time and limits areas where work may be accomplished on board ship.

Arresting gear actuator designs which incorporate integral pressure sources should have consideration given toward inclusion of a fuselage servicing center rather than allowing accomplishment of servicing in the space-limited area around the actuator.

Avoid disassembly of links, snubbers, etc. when accomplishing hook shank removal only.

TABLE 6.15 MAINTENANCE DATA - BRAKE CONTROL VALVE

WORK UNIT CODES

A-4	N/A	A-6	N/A	A-7	1352A	AV-8	13726	F-4	13411
F-8	N/A	F-14	13821	P-3	N/A	S-3	13622		

ORGANIZATIONAL LEVEL

A/C	FLIGHT HOURS	MFHBMA	MA/FH X10-3	MTTR	MMH/MA	MEN/MA	MMH/FH	R+R	O+I MTBF
A-4M	35,571								
A-6E	87,564								
A-7E	159,611	3,011.5	0.3	3.11	5.29	1.7	.002	8.49	6,139
AV-8A	19,396	1,293.1	0.8	6.23	11.53	1.9	.009	8.20	2,425
F-4J	115,070	408.0	2.5	4.37	8.43	1.9	.021	9.97	619
F-8J	18,317								
F-14A	51,286	198.8	5.0	3.83	10.08	2.6	.051	5.60	462
P-3C	125,860								
S-3A	60,552	3,364.0	0.3	3.02	7.14	2.4	.002	4.33	6,728

INTERMEDIATE LEVEL

A/C	FLIGHT HOURS	MFHBMA	MA/FH X10-3	MTTR	MMH/MA	MEN/MA	MMH/FH
A-4M	35,571						
A-6E	87,564						
A-7E	159,611	19,951.4	0.1	0.00	0.00		
AV-8A	19,396	4,849.0	0.2	4.10	8.20	2.0	.002
F-4J	115,070	1,322.6	0.8	2.59	3.08	1.2	.002
F-8J	18,317						
F-14A	51,286	539.9	1.9	7.28	10.77	1.5	.020
P-3C	125,860						
S-3A	60,552	7,569.0	0.1	2.13	2.13	1.0	.000

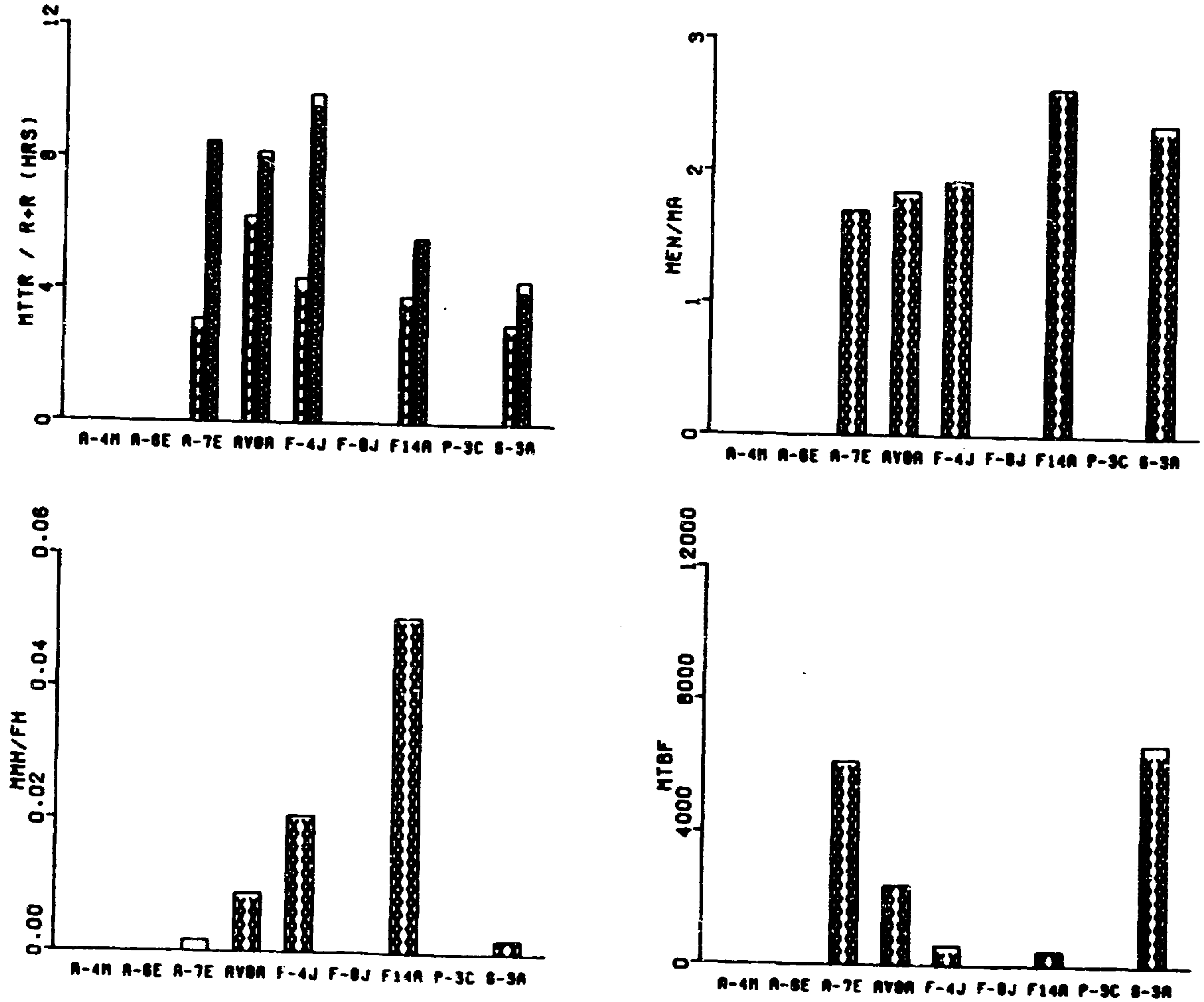


FIGURE 6.15 SELECTED GRAPHICAL DATA - BRAKE CONTROL VALVE

6.6.8 Brake Control Valve (See preceding Table and Figure 6.15)

WORK UNIT CODES

A-4 N/A	A-6 N/A	A-7 1352A	AV-8 13726	F-4 13411
F-8 N/A	F-14 13821	F-3 N/A	S-3 13622	

DISCUSSION

Comments:

The nomenclature, brake control valve, is somewhat misleading. Included in the heading are conventional brake pedal valves, anti-skid control valves, and an anti-skid control box. Therefore, analysis of installation and 3-M data between aircraft must be reviewed and utilized with this in mind. Traditionally, brake pedal valves are located forward of the brake pedals in the cockpit, are time consuming to replace, and require a contortionist to perform maintenance. The AV-8A and especially the F-4J are typical and the quantitative data bears this out. Blind mountings, inaccessability, and the need to accomplish tasks in two different areas contribute to the very high F-4J R+R time. A more accessible location has enabled S-3A technicians to substantially reduce their maintenance expenditures; but the use of brazed hydraulic tubing on the A-7E negated the benefits of a similar location.

Recommendations:

Relocate brake pedal valves from the cockpit to a more accessible location or less preferable, provide exterior access to the pedal valve.

Avoid the use of brazed hydraulic tubing as this tubing is inflexible and unnecessarily adds difficulty to replacement tasks.

Locating landing gear associated components in wheel wells is a strong feature; however, components should be positioned with sufficient hand and tool room to remove electrical connectors and hydraulic lines.

Electronic control boxes should utilize BIT, as in the F-14A, to eliminate PGSE requirements.

TABLE 6.16 MAINTENANCE DATA - EMERGENCY AIR BOTTLE/ACCUMULATOR

WORK UNIT CODES

A-4	N/A	A-6	13451	A-7	13311	AV-8	13415	F-4	13153
F-8	N/A	F-14	13712	P-3	13538	S-3	13632		

ORGANIZATIONAL LEVEL

A/C	FLIGHT HOURS	MFHBMA	MA/FH X10-3	MTTR	MMH/MA	MEN/MA	MMH/FH	R+R	O+I MTBF
A-4M	35,571								
A-6E	87,564	254.5	3.9	4.50	9.34	2.1	.037	9.82	419
A-7E	159,611	516.5	1.9	2.87	6.77	2.4	.013	4.29	1,017
AV-8A	19,396	3,879.2	0.3	1.24	1.80	1.5	.000		9,698
F-4J	115,070	4,794.6	0.2	3.35	5.71	1.7	.001	4.83	5,056
F-8J	18,317								
F-14A	51,286	1,282.2	0.8	1.70	2.80	1.6	.002		2,137
P-3C	125,860	418.1	2.4	1.47	2.63	1.8	.006	5.15	494
S-3A	60,552	961.1	1.0	1.09	2.06	1.9	.002	3.50	1,553

INTERMEDIATE LEVEL

A/C	FLIGHT HOURS	MFHBMA	MA/FH X10-3	MTTR	MMH/MA	MEN/MA	MMH/FH
A-4M	35,571						
A-6E	87,564	1,751.3	0.6	5.17	7.07	1.4	.004
A-7E	159,611	1,534.7	0.7	6.36	8.12	1.3	.005
AV-8A	19,396						
F-4J	115,070	38,356.7	0.0	0.67	0.67	1.0	.000
F-8J	18,317						
F-14A	51,286	51,286.0	0.0	0.00	0.00		
P-3C	125,860	11,441.8	0.1	4.77	7.50	1.6	.001
S-3A	60,552	20,184.0	0.0	4.33	5.67	1.3	.000

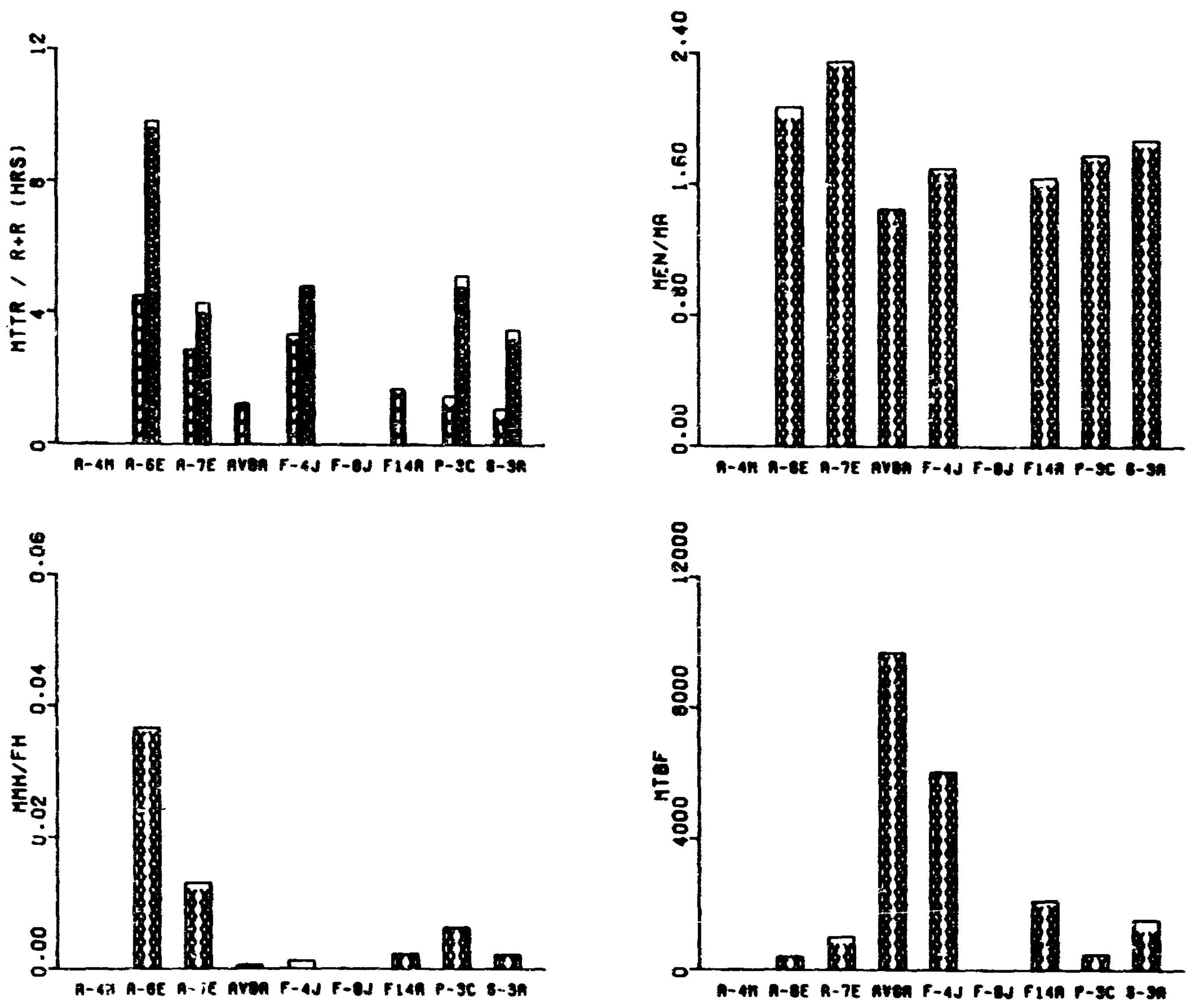


FIGURE 6.16 SELECTED GRAPHICAL DATA - EMERGENCY AIR BOTTLE/ACCUMULATOR

6.6.9 Emergency Air Bottle/Accumulator (See preceding Table and Figure 6.16)

WORK UNIT CODES

A-4 N/A	A-6 13451	A-7 13311	AV-8 13415	F-4 13153
F-8 N/A	F-14 13712	P-3 13538	S-3 13632	

DISCUSSION

Comments:

Analysis of the quantitative data indicates that this component is a fairly reliable one. Two aircraft, AV-8A and F-14A, had no removals logged against them which in itself is a compliment. All the emergency air bottles/accumulators are pneumatic except the A-7E which is hydraulic/pneumatic. Designs, utilizing pneumatics only, greatly simplify the remove and replace action. Such designs employ a simple clamping arrangement with minimum connections. The S-3A 3-M values reflect this simplicity. This combined with outstanding access make it an excellent installation from a maintainability point of view. The F-14A is a similar design. Excessive access requirements or lack of hand/tool room negate the ease of removal in the A-6E, F-4J, P-3C, and one of the two air bottles on the AV-8A. The quantitative numbers confirm this qualitative assessment.

Recommendations:

Build-up of hydraulic accumulators should take place in the Intermediate shop not on the aircraft. Such accumulators should be ready for installation when drawn from supply.

Eliminate the requirement of removing or displacing non-associated equipment when replacing the air bottle.

Marked improvement in maintenance rates may be obtained by ensuring the technician has sufficient hand and tool room to remove mounting. Band type mounts are time savers.

Although generally a highly reliable component, these components should not be completely buried because eventually some one will have to replace it.

TABLE 6.17 MAINTENANCE DATA - ELEVATOR/UHT ACTUATOR

WORK UNIT CODES

A-4	14321	A-6	14521	A-7	14531	AV-8	14331	F-4	14326
F-8	14420	F-14	14431	P-3	14832	S-3	N/A		

ORGANIZATIONAL LEVEL

A/C	FLIGHT HOURS	MFHBMA	MA/FH X10-3	MTTR	MMH/MA	MEN/MA	MMH/FH	R+R	O+I MTBF
A-4M	35,571	936.1	1.1	2.81	5.41	1.9	.006	8.23	2,371
A-6E	87,564	357.4	2.8	7.91	21.28	2.7	.060	14.70	668
A-7E	159,611	609.2	1.6	8.81	20.58	2.3	.034	13.23	1,353
AV-8A	19,396	473.1	2.1	4.93	10.64	2.2	.022	7.18	882
F-4J	115,070	399.5	2.5	9.95	24.23	2.4	.061	13.29	715
F-8J	18,317	964.1	1.0	2.95	5.37	1.8	.006		1,526
F-14A	51,286	189.2	5.3	5.48	14.78	2.7	.078	10.27	625
P-3C	125,860	642.1	1.6	4.02	8.43	2.1	.013	7.63	1,134
S-3A	60,552								

INTERMEDIATE LEVEL

A/C	FLIGHT HOURS	MFHBMA	MA/FH X10-3	MTTR	MMH/MA	MEN/MA	MMH/FH
A-4M	35,571	7,114.2	0.1	0.58	0.68	1.2	.000
A-6E	87,564	1,006.5	1.0	3.67	6.16	1.7	.006
A-7E	159,611	1,100.8	0.9	0.71	1.06	1.5	.001
AV-8A	19,396	843.3	1.2	1.76	3.25	1.9	.004
F-4J	115,070	757.0	1.3	4.03	7.99	2.0	.011
F-8J	18,317						
F-14A	51,286	840.8	1.2	1.44	2.15	1.5	.003
P-3C	125,860	2,030.0	0.5	6.41	11.16	1.7	.005
S-3A	60,552						

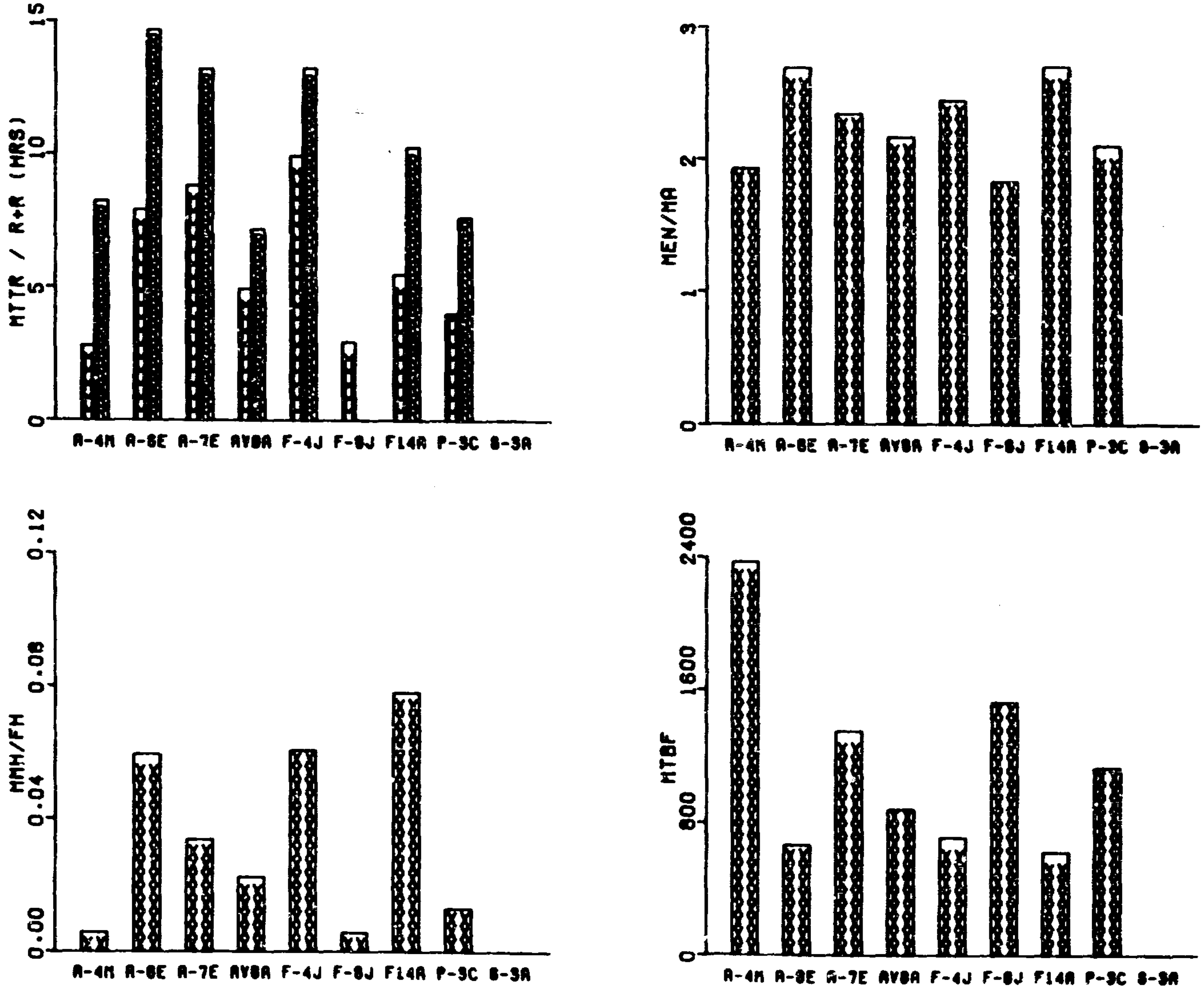


FIGURE 6.17 SELECTED GRAPHICAL DATA - ELEVATOR/UHT ACTUATOR

6.7 FLIGHT CONTROL SYSTEM

6.7.1 Elevator/UHT Actuator (See preceding Table and Figure 6.17)

WORK UNIT CODES

A-4 14321	A-6 14521	A-7 14531	AV-8 14331	F-4 14326
F-8 1442D	F-14 14431	P-3 14832	S-3 N/A	

DISCUSSION

Comments:

This component is characterized by its relatively large size and its very heavy weight. Analysis indicates that two qualitative features have a positive effect on easing the maintenance burden: optimizing access from the exterior of the aircraft (maximum availability of access at critical working areas with a minimum number of panels to be removed) and optimizing hand/tool room around attach points and connectors. The design of the AV-8 elevator actuator provides plenty of room for hands/tools and the access holes are small and well coordinated to facilitate removal. Likewise, the P-3C, being as large as it is, has more than sufficient room for the actuator. The 3-M data reflects these qualities, as these two aircraft required the least amount of R+R time. The A-6E, A-7E, and F-4J replacement time runs high due to large numbers of fasteners on exterior panels and the difficulty manipulating attachment hardware. Four of the aircraft installations are accessible from deck level, a good maintenance feature. However, the quantitative impact of this feature cannot be assessed from the 3-M data. The F-8J was not subjected to quantitative analysis because it had zero reported removals.

Recommendations:

Panel removal is a necessary fact of this installation; however, designs should require that quantities of panels and fasteners that have to be removed to accomplish a specific R+R action be kept to an absolute minimum.

Avoid placing attachment hardware in tight spaces where hand and tool room is limited.

Eliminate special tool requirements and use of peculiar hardware such as tapered bolts and matched hardware sets. (Matched sets of hardware is hardware where top and bottom portions fit each other exactly and cannot be used in conjunction with parts of other like Matched Sets.)

Avoid displacing wire bundles and hydraulic lines or requiring non-associated equipment to be removed or displaced.

TABLE 6.18 MAINTENANCE DATA - AILERON ACTUATOR

WORK UNIT CODES

A-4	14221	A-6	14321	A-7	14233	AV-8	14131	F-4	14222
F-8	14231	F-14	N/A	P-3	N/A	S-3	N/A		

ORGANIZATIONAL LEVEL

A/C	FLIGHT HOURS	MFHBMA	MA/FH X10-3	MTTR	MMH/MA	MEN/MA	MMH/FH	R+R	O+I MTBF
A-4M	35,571	624.1	1.6	7.08	15.94	2.3	.026	24.60	1,186
A-6E	87,564	286.2	3.5	6.86	14.84	2.2	.052	12.47	544
A-7E	159,611	302.3	3.3	4.51	9.88	2.2	.033	8.89	682
AV-8A	19,396	192.0	5.2	6.67	11.00	1.6	.057	10.51	431
F-4J	115,070	289.1	3.5	7.86	16.73	2.1	.058	13.73	443
F-8J	18,317	631.6	1.6	5.69	13.16	2.3	.021	7.50	1,665
F-14A	51,286								
P-3C	125,860								
S-3A	60,552								

INTERMEDIATE LEVEL

A/C	FLIGHT HOURS	MFHBMA	MA/FH X10-3	MTTR	MMH/MA	MEN/MA	MMH/FH
A-4M	35,571	2,964.3	0.3	0.23	0.27	1.2	.000
A-6E	87,564	706.2	1.4	5.51	8.50	1.5	.012
A-7E	159,611	1,124.0	0.9	5.24	6.75	1.3	.006
AV-8A	19,396	404.1	2.5	1.06	1.80	1.7	.004
F-4J	115,070	1,117.2	0.9	4.57	5.36	1.2	.005
F-8J	18,317	1,409.0	0.7	8.96	9.42	1.1	.007
F-14A	51,286						
P-3C	125,860						
S-3A	60,552						

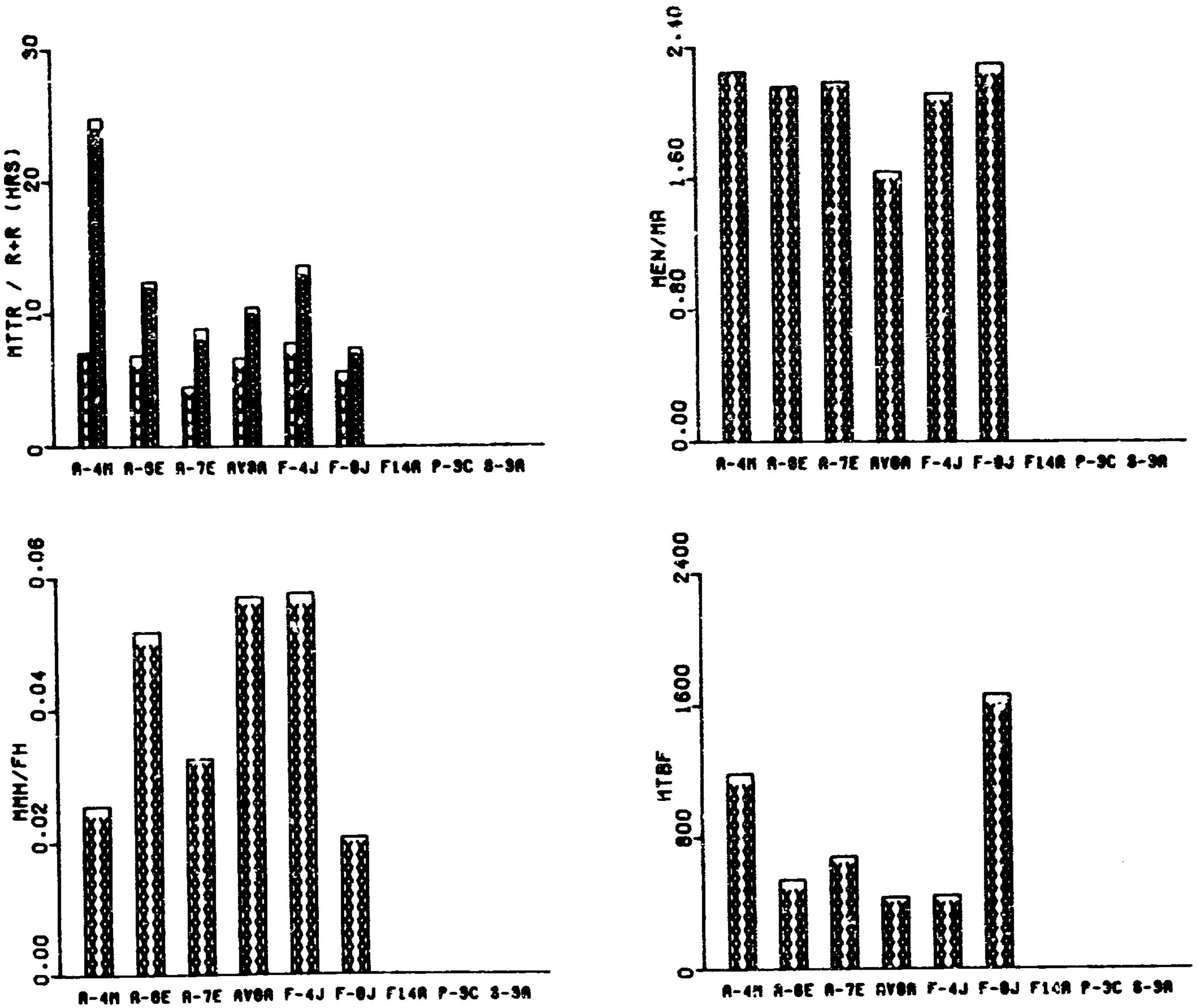


FIGURE 6.18 SELECTED GRAPHICAL DATA - AILERON ACTUATOR

6.7.2 Aileron Actuator (See preceding Table and Figure 6.18)

WORK UNIT CODES

A-4 14221	A-6 14321	A-7 14233	AV-8 14131	F-4 14222
F-8 14231	F-14 N/A	P-3 N/A	S-3 N/A	

DISCUSSION

<u>Comments</u>:

Location and available room for the installations are the qualitative features which seem to drive the quantitative data. The A-4M's low wing configuration compounds the difficulty working in a very conjested actuator compartment on the lower wing surface. The large access panel on the F-4J provides more than enough room to see the aileron actuator but requires almost two hours to remove and replace. (Based on the standard of 0.70 minutes to remove and replace each of the 146 screws.) The A-7E records the best replacement time according to the 3-M data and this is due to the ease of reaching all but one piece of attachment hardware. The F-8J data sample for replacement actions is too small to make a valid statistical comparison of its R+R time to the other aircraft.

<u>Recommendations</u>:

Minimize the number of fasteners required to effect panel removal or break unwieldy large panels into several smaller ones which use latches rather than screws or fasteners wherever possible.

Although in a traditionally tight space due to wing box design, maximum effort should be made to optimize hand and tool room around attach points. If necessary additional access could be provided on the opposite wing surface.

TABLE 6.19 MAINTENANCE DATA - AILERON TRIM ACTUATOR

WORK UNIT CODES

A-4	14211	A-6	N/A	A-7	14241	AV-8	14142	F-4	14261
F-8	N/A	F-14	14234	P-3	N/A	S-3	14221		

ORGANIZATIONAL LEVEL

A/C	FLIGHT HOURS	MFHBMA	MA/FH X10-3	MTTR	MMH/MA	MEN/MA	MMH/FH	R+R	O+I MTBF
A-4M	35,571	2,964.3	0.3	6.20	8.52	1.4	.003	3.43	5,929
A-6E	87,564								
A-7E	159,611	1,923.0	0.5	4.52	9.70	2.1	.005	6.46	3,130
AV-8A	19,396	2,155.1	0.5	4.92	12.11	2.5	.006	7.00	3,233
F-4J	115,070	2,171.1	0.5	7.52	15.87	2.1	.007	10.21	3,384
F-8J	18,317								
F-14A	51,286	732.7	1.4	4.47	11.91	2.7	.016	7.27	1,350
P-3C	125,860								
S-3A	60,552	313.7	3.2	8.04	16.65	2.1	.052	15.23	904

INTERMEDIATE LEVEL

A/C	FLIGHT HOURS	MFHBMA	MA/FH X10-3	MTTR	MMH/MA	MEN/MA	MMH/FH
A-4M	35,571	17,785.5	0.1	0.75	1.25	1.7	.000
A-6E	87,564						
A-7E	159,611	5,503.8	0.2	0.59	0.79	1.4	.000
AV-8A	19,396	6,465.3	0.2	0.67	0.67	1.0	.000
F-4J	115,070	6,392.0	0.2	2.64	2.81	1.1	.000
F-8J	18,317						
F-14A	51,286	1,282.2	0.8	6.04	9.83	1.6	.008
P-3C	125,860						
S-3A	60,552	1,062.3	0.9	2.91	3.37	1.2	.003

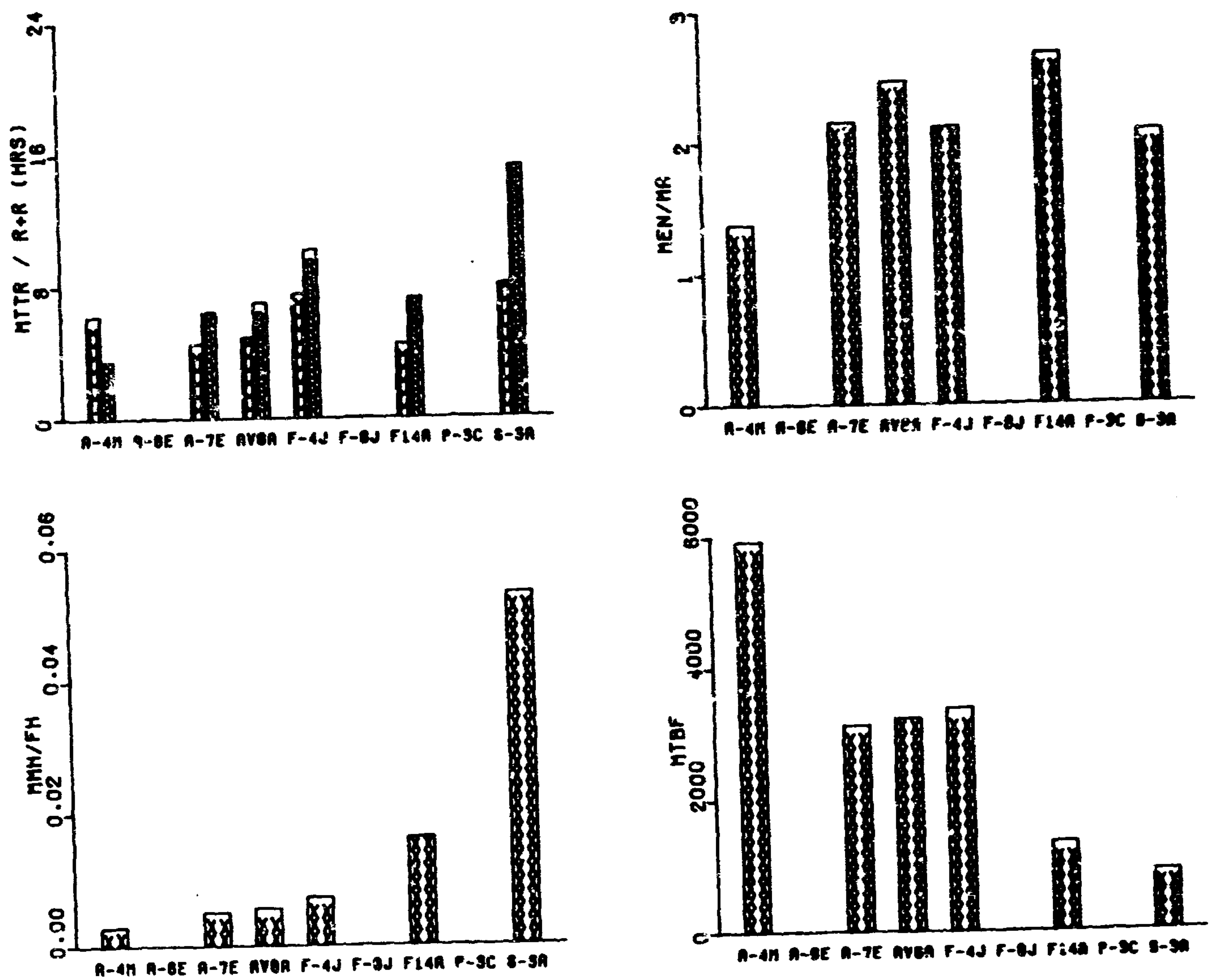


FIGURE 6.19 SELECTED GRAPHICAL DATA - AILERON TRIM ACTUATOR

6.7.3 Aileron Trim Actuator (See preceding Table and Figure 6.19)

WORK UNIT CODES

A-4 1421L	A-6 N/A	A-7 14241	AV-8 14142	F-4 14261
F-8 N/A	F-14 14234	P-3 N/A	S-3 14221	

DISCUSSION

Comments:

As with other flight control actuators, the maintenance parameters of the aileron trim actuator are adversely impacted by cramped installation spaces. Both hydraulic and electromechanical actuation is employed in the aircraft surveyed with less disassembly or removal of attaching hardware required on a electro-mechanical actuators. The excessive remove and replace maintenance time reported for the S-3A electro-mechanical actuator is a reaction to the extreme difficulty technicians have inserting the upper attachment hardware. This difficulty is generated by the physical size and weight of the actuator which inhibits maneuvering of the unit. The S-3A's high maintenance parameters could have been lowered by increasing the size of existing accesses to provide improved hand/tool room and by adding an additional access to the opposite side of the vertical stabilizer. The A-4M and AV-8A R+R times are statistically invalid because of small sample sizes (three and one remove and replace actions respectively). Quantitatively, the A-7E would seem to be a better installation than the F-14A. However, qualitatively the opposite is true. The A-7E actuator is buried and requires blind work while the F-14A is a simple straightforward removal. Possibly the difference is due to a longer familiarity of the A-7E in the Naval community than of the F-14A.

Recommendations:

Eliminate the requirement for removal or displacement of non-associated equipment.

On large, heavy actuators allow for sub-component replacement without requiring complete actuator removal.

Ensure sufficient room is provided for hand and tool room and avoid blind work. Improvement of these two traits will be substantial time savers. When components are located in the vertical stabilizer, thought should be given toward having accesses on both sides.

TABLE 6.20 MAINTENANCE DATA - SPOILER ACTUATOR

WORK UNIT CODES

A-4	14A22	A-6	N/A	A-7	14238	AV-8	N/A	F-4	14252
F-8	14232	F-14	14232	P-3	N/A	S-3	N/A		

ORGANIZATIONAL LEVEL

A/C	FLIGHT HOURS	MFHBMA	MA/FH X10-3	MTTR	MMH/MA	MEN/MA	MMH/FH	R+R	O+I MTBF
A-4M	35,571	8,892.8	0.1	2.13	4.25	2.0	.000	3.50	35,571
A-6E	87,564								
A-7E	159,611	886.7	1.1	4.76	9.80	2.1	.011	8.39	1,663
AV-8A	19,396								
F-4J	115,070	408.0	2.5	6.07	13.09	2.2	.032	8.17	622
F-8J	18,317	495.1	2.0	7.86	16.18	2.1	.033	13.60	632
F-14A	51,286	203.5	4.9	7.20	17.59	2.4	.086	10.92	488
P-3C	125,860								
S-3A	60,552								

INTERMEDIATE LEVEL

A/C	FLIGHT HOURS	MFHBMA	MA/FH X10-3	MTTR	MMH/MA	MEN/MA	MMH/FH
A-4M	35,571	35,571.0	0.0	1.00	1.00	1.0	.000
A-6E	87,564						
A-7E	159,611	2,418.3	0.4	4.40	5.21	1.2	.002
AV-8A	19,396						
F-4J	115,070	1,075.4	0.9	4.87	5.52	1.1	.005
F-8J	18,317	1,409.0	0.7	2.81	2.81	1.0	.002
F-14A	51,286	483.8	2.1	9.25	15.27	1.7	.032
P-3C	125,860						
S-3A	60,552						

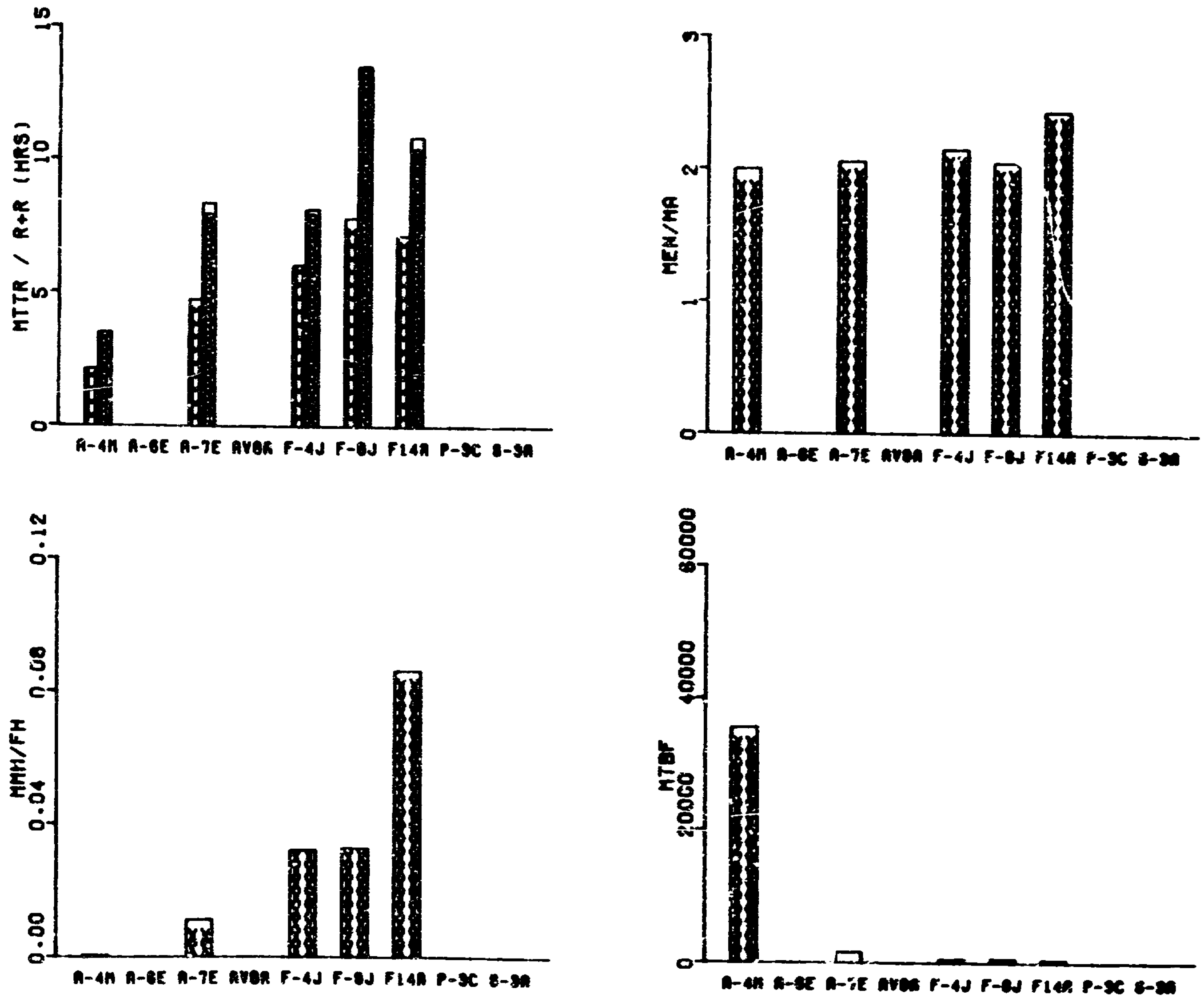


FIGURE 6.20 SELECTED GRAPHICAL DATA - SPOILER ACTUATOR

6.7.4 Spoiler Actuator (*See preceding Table and Figure 6.20*)

WORK UNIT CODES

A-4 14A22	A-6 N/A	A-7 1423B	AV-8 N/A	F-4 14252
F-8 14232	F-14 14232	P-3 N/A	S-3 N/A	

DISCUSSION

Comments:

The A-7E spoiler actuator installation does not require panel removal, a strong point maintainability-wise and a maintenance time saver. However, savings generated by this feature have been negated by other aspects of the installation because quantitatively the A-7E 3-M data is about the same as other aircraft. The conventional panel covered F-4J actuator would have a better replacement time if it was not encumbered by an access panel too large for the task. The time to remove the added fasteners, up to 266 for the outboard spoiler, is reflected in the R+R time. Installing two actuators in the F-8J spoiler area makes working on either actuator very difficult, hence the very high replacement time. Even though the sample size of the A-4M remove and replace time is so small as to be statistically invalid, its simple removal tasks are reflected in the remainder of the maintenance parameters.

Recommendations:

Avoid using panels which are larger than required to remove the component. Whenever possible, the use of latches rather than screws or fasteners is preferred as latches are a better maintenance expedient.

Ensure adequate hand/tool room is available for the maintenance technician.

TABLE 6.21 MAINTENANCE DATA - RUDDER ACTUATOR

WORK UNIT CODES

A-4	14721	A-6	14421	A-7	14431	AV-8	N/A	F-4	14428
F-8	N/A	F-14	14342	P-3	14833	S-3	N/A		

ORGANIZATIONAL LEVEL

A/C	FLIGHT HOURS	MFHBMA	MA/FH X10-3	MTTR	MMH/MA	MEN/MA	MMH/FH	R+R	O+I MTBF
A-4M	35,571	4,446.4	0.2	4.55	9.49	2.1	.002	6.39	8,893
A-6E	87,564	463.3	2.2	7.63	17.60	2.3	.038	13.55	712
A-7E	159,611	1,680.1	0.6	5.83	12.71	2.2	.008	7.47	2,902
AV-8A	19,396								
F-4J	115,070	350.8	2.9	7.30	15.52	2.1	.044	9.25	525
F-8J	18,317								
F-14A	51,286	1,005.6	1.0	3.89	9.87	2.5	.010	7.14	3,205
P-3C	125,860	762.8	1.3	3.39	7.14	2.1	.009	8.86	1,824
S-3A	60,552								

INTERMEDIATE LEVEL

A/C	FLIGHT HOURS	MFHBMA	MA/FH X10-3	MTTR	MMH/MA	MEN/MA	MMH/FH
A-4M	35,571	7,114.2	0.1	0.76	1.12	1.5	.000
A-6E	87,564	1,067.9	0.9	4.07	5.66	1.4	.005
A-7E	159,611	4,560.3	0.2	5.25	5.97	1.1	.001
AV-8A	19,396						
F-4J	115,070	509.2	2.0	4.45	5.08	1.1	.010
F-8J	18,317						
F-14A	51,286	2,442.2	0.4	5.90	6.85	1.2	.003
P-3C	125,860	3,496.1	0.3	5.92	10.13	1.7	.003
S-3A	60,552						

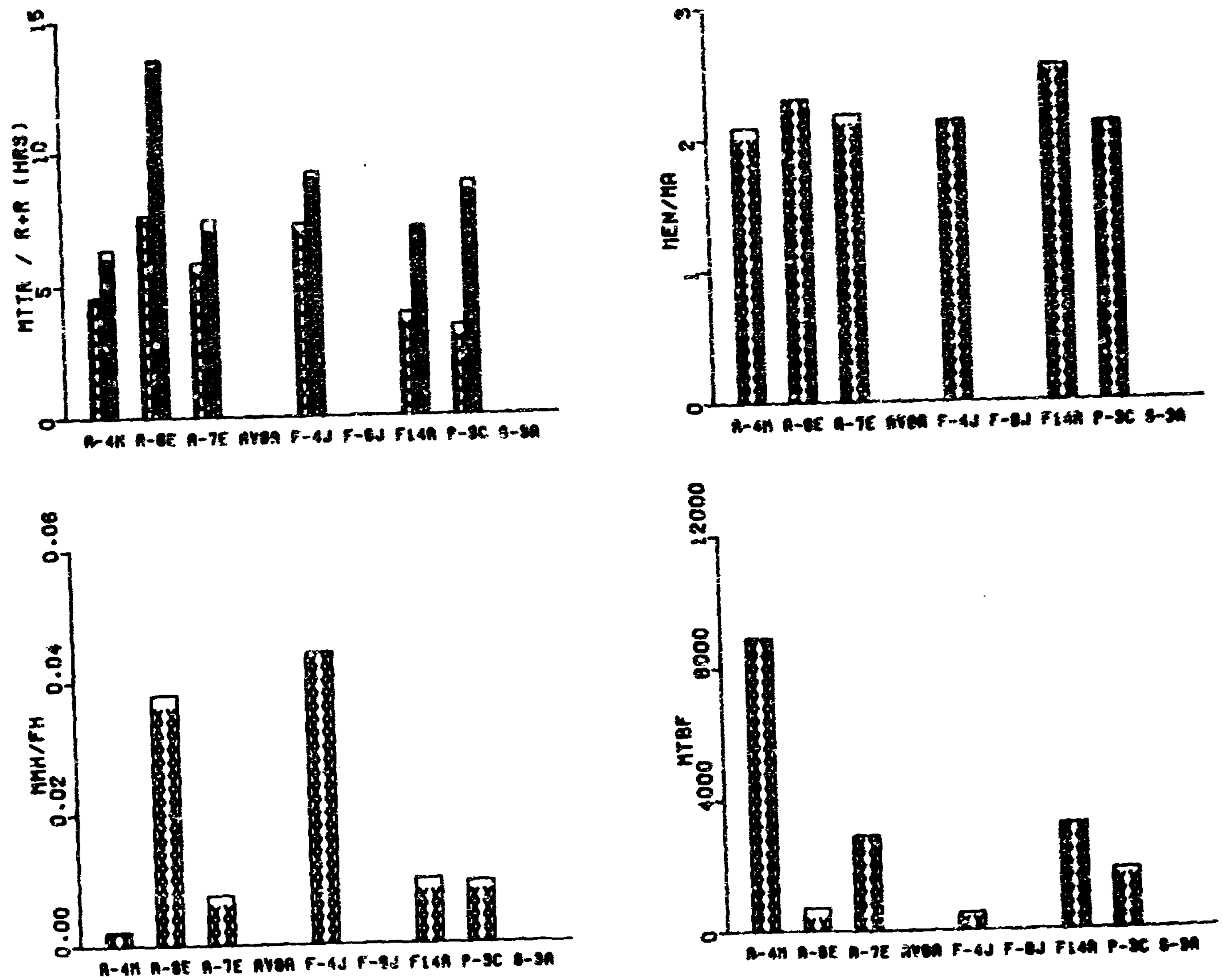


FIGURE 6.21 SELECTED GRAPHICAL DATA - RUDDER ACTUATOR

6.7.5 Rudder Actuator (See preceding Table and Figure 6.21)

WORK UNIT CODES

A-4 14721	A-6 14421	A-7 14431	AV-8 N/A	F-4 14423
F-8 N/A	F-14 14342	P-3 14833	S-3 N/A	

DISCUSSION

Comments:

Analysis of the qualitative features described in references one and two indicates, as with other flight control actuators, that either lack of space or access requirements are at fault for pushing the 3-M replacement times up. The A-6E rudder actuator quantitively shows the greatest maintenance burden of all surveyed actuators. It is installed in the narrowing cross section of the tailcone restricting work space for linkage disconnection and actuator lug end attachment hardware. The 3-M maintenance values for the rudder actuator on the F-4J and the right-hand actuator on the F-14A are affected because of the difficulties caused by working on or near fuselage surfaces which slope (the horizontal tail negative dihedral on the F-4J and the outward sloping of the F-14A vertical tail). On the other hand, the A-4M which was the lowest in R+R time, has all but one item of attachment hardware in plain sight. It also employs a rubber ring on each of the hydraulic hoses which holds the hoses steady between the skin panel and the structure, thus eliminating time that would normally be required to unclamp the hoses.

Recommendations:

Avoid use of special attachment hardware or matched sets of hardware as this may induce improper maintenance. (Matched sets of hardware are hardware where top and bottom portions fit each other exactly and cannot be used in conjunction with parts of other like matched sets.)

Ensure proper amount of space is provided for hand/tool room.

TABLE 6.22 MAINTENANCE DATA - TE FLAP ACTUATOR

WORK UNIT CODES

A-4	N/A	A-6	N/A	A-7	14757	AV-8	14532	F-4	14555
F-8	N/A	F-14	14620	P-3	N/A	S-3	N/A		

ORGANIZATIONAL LEVEL

A/C	FLIGHT HOURS	MFHBMA	MA/FH X10-3	MTTR	MMH/MA	MEN/MA	MMH/FH	R+R	O+I MTBF
A-4M	35,571								
A-6E	87,564								
A-7E	159,611	5,911.5	0.2	4.92	10.75	2.2	.002	12.86	11,401
AV-8A	19,396	9,698.0	0.1	5.65	5.90	1.0	.001	9.30	19,396
F-4J	115,070	248.9	4.0	9.62	22.05	2.3	.089	14.67	511
F-8J	18,317								
F-14A	51,286	100.0	10.0	7.14	18.73	2.6	.187	12.91	218
P-3C	125,860								
S-3A	60,552								

INTERMEDIATE LEVEL

A/C	FLIGHT HOURS	MFHBMA	MA/FH X10-3	MTTR	MMH/MA	MEN/MA	MMH/FH
A-4M	35,571						
A-6E	87,564						
A-7E	159,611	22,801.6	0.0	6.71	11.21	1.7	.000
AV-8A	19,396	19,396.0	0.1	2.50	5.00	2.0	.000
F-4J	115,070	491.8	2.0	3.08	4.07	1.3	.008
F-8J	18,317						
F-14A	51,286	356.2	2.8	1.94	2.53	1.3	.007
P-3C	125,860						
S-3A	60,552						

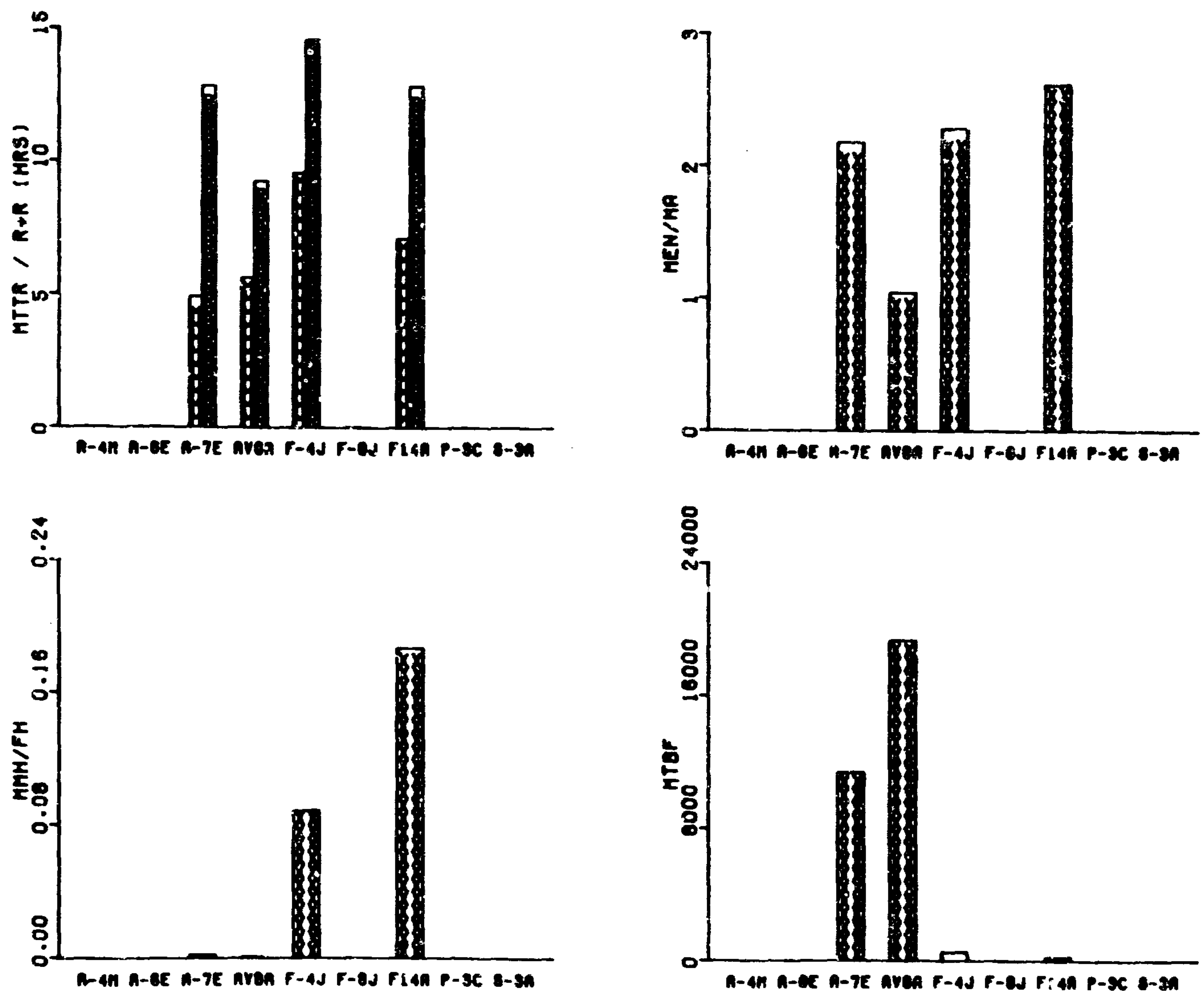


FIGURE 6.22 SELECTED GRAPHICAL DATA - TE FLAP ACTUATOR

6.7.6 Trailing Edge Flap Actuator (See preceding Table and Figure 6.22)

WORK UNIT CODES

A-4 N/A	A-6 N/A	A-7 14757	AV-8 14532	F-4 14555
F-8 N/A	F-14 1462Q	F-3 N/A	S-3 N/A	

DISCUSSION

Comments:

Qualitatively, the AV-8A is the best installation surveyed. The removal steps are straightforward and simple once access has been obtained. However, the quantitative data sample available is too small for analysis and the information should be set aside. (Only one remove and replace action and two maintenance actions overall were logged against the aircraft actuator in eighteen months). Cramped spaces have the greatest impact on replacement times for trailing edge actuators. Specifically, the inability to reach attach points and electrical connectors on the F-4J, coupled with a low reliability, make the installation barely tenable. Although the attachment hardware is visible in the clamped quarters of the F-14A installation, its low reliability makes the installation just as unacceptable as the F-4J.

Recommendations:

This is generally a time consuming repair item and if reliability is predicted to be low, optimizing the maintainability features become paramount. For example, attachment bolts should be visible with sufficient hand/tool room around them; removals to gain access should be limited; and actuator rigging and operational checkout simplified by making linkage or turnbuckle alignment not as critical in tolerance or by eliminating requirements for contour boards.

TABLE 6.23 MAINTENANCE DATA - HORIZONTAL STABILIZER/ELEVATOR

WORK UNIT CODES

A-4	14611	A-6	14131	A-7	14511	AV-8	14310	F-4	14310
F-8	1441G	F-14	14411	P-3	N/A	S-3	14125		

ORGANIZATIONAL LEVEL

A/C	FLIGHT HOURS	MFHBMA	MA/FH X10-3	MTTR	MMH/MA	MEN/MA	MMH/FH	R+R	O+I MTBF
A-4M	35,571	1,111.6	0.9	1.53	2.52	1.6	.002	9.85	2,736
A-6E	87,564	170.7	5.9	1.97	3.33	1.7	.020	3.19	249
A-7E	159,611	440.9	2.3	3.22	6.93	2.2	.016	12.51	530
AV-8A	19,396	148.1	6.8	4.22	8.50	2.0	.057	5.33	237
F-4J	115,070	29.3	34.1	3.36	6.33	1.9	.216	15.50	46
F-8J	18,317	194.9	5.1	5.64	12.11	2.1	.062	8.00	215
F-14A	51,286	100.6	9.9	4.28	9.93	2.3	.099	9.62	116
P-3C	125,860								
S-3A	60,552	406.4	2.5	2.96	4.48	1.5	.011		500

INTERMEDIATE LEVEL

A/C	FLIGHT HOURS	MFHBMA	MA/FH X10-3	MTTR	MMH/MA	MEN/MA	MMH/FH
A-4M	35,571	17,785.5	0.1	2.75	4.00	1.5	.000
A-6E	87,564	2,501.8	0.4	13.01	15.85	1.2	.006
A-7E	159,611	12,277.8	0.1	3.22	4.95	1.5	.000
AV-8A	19,396	1,939.6	0.5	3.70	6.90	1.9	.004
F-4J	115,070	1,027.4	1.0	9.96	28.88	2.9	.028
F-8J	18,317	9,158.5	0.1	19.00	19.00	1.0	.002
F-14A	51,286	6,410.8	0.2	4.06	7.31	1.8	.001
P-3C	125,860						
S-3A	60,552	60,552.0	0.0	0.50	0.50	1.0	.000

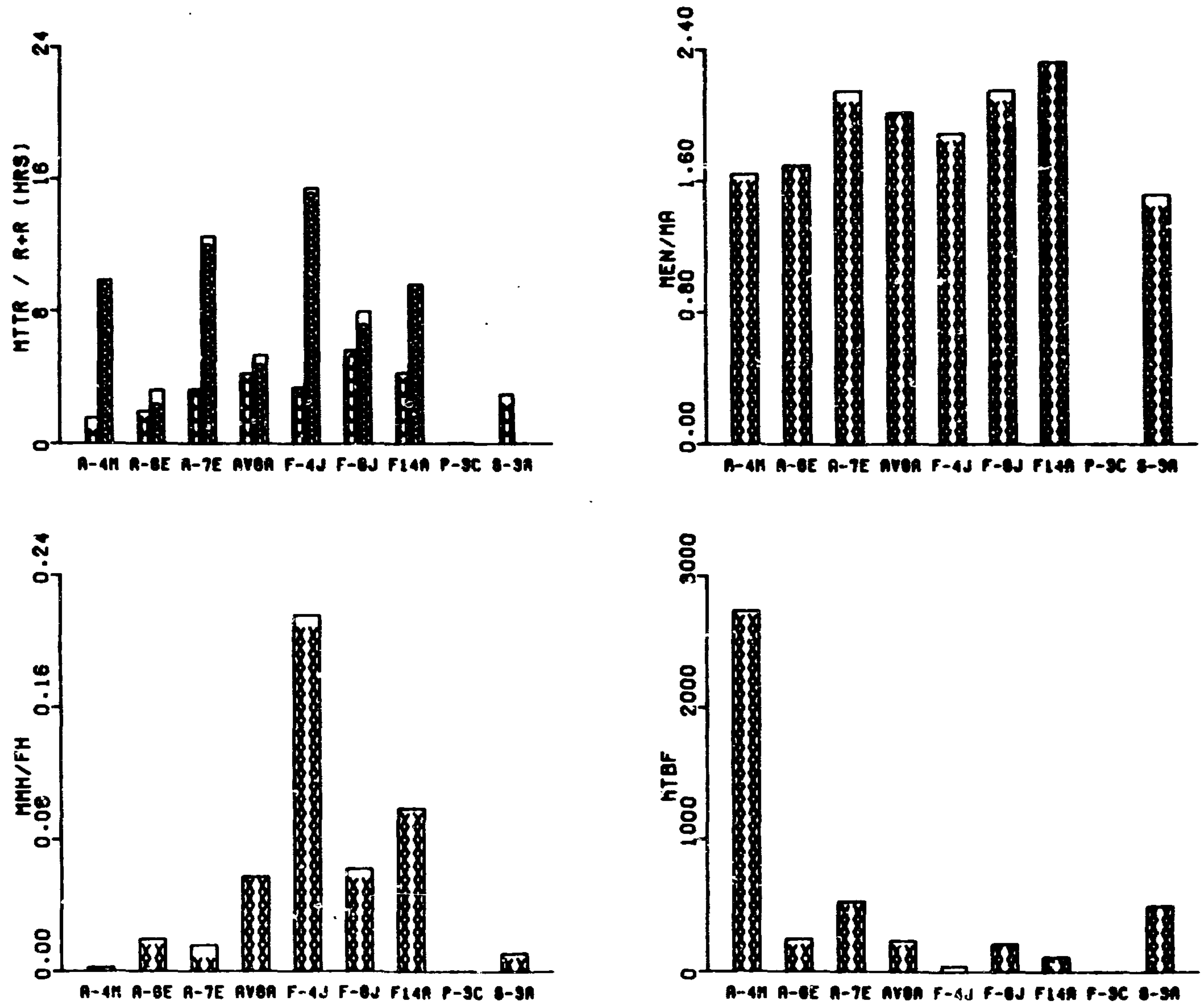


FIGURE 6.23 SELECTED GRAPHICAL DATA - HORIZONTAL STABILIZER/ELEVATOR

6.7.7 Horizontal Stabilizer/Elevator (See preceding Table and Figure 6.23)

WORK UNIT CODES

A-4 14611	A-6 14131	A-7 145[illegible]1	AV-8 14310	F-4 14310
F-8 1441G	F-14 14411	P-3 N/A	S-3 14125	

DISCUSSION

Comments:

The sample size of remove and replace actions varies considerably among the aircraft surveyed. The S-3A had no removals, the F-8J had one, and the A-4M only two. This makes the results of a quantitative analysis of the three aircraft suspect and the data statistically unrepresentative of true average replacement times. The A-6E surpassed its counterparts qualitatively and quantitatively. The unit bolts directly to the stabilizer shaft; and, when the bolts are removed, the surface slides off the shaft with no further disassembly. This design allows not only for simplified removal of a large, heavy surface, but also eliminates the need for rigging and operational checks. These features are strongly reflected in the fleet maintenance values. The remainder of the surface attach points suffer from varying degrees of poor access and/or disassembly. Much of the F-4J replacement time, over fifteen hours, is due to excessive disassembly of the aft fuselage and non-associated equipment such as fuel lines, antennae, and a drag chute; all of which require checkout when reconnected. The S-3A, even though no removals occurred in the time frame reviewed, would similarly suffer from extensive disassembly. Access provisions on the A-4M, A-7E, AV-8A, F-8J, and F-14A require more maintenance resources and therefore seem to have extracted more time as evidenced by the 3-M data. Three aircraft, A-7E, F-8J, and F-14A, may be worked on at deck level. This is preferred in a design because of the reduction in the support equipment required, and the savings in elapsed maintenance time relative to use of the GSE.

Recommendations:

Avoid the need to jack an aircraft to replace the horizontal stabilizer.

Rivet (F-8J) removal to gain access to components is totally unacceptable.

Avoid disassembly or removal of unassociated equipment such as fuel vent lines and antennae as these require additional checkout upon installation.

Minimize aft fuselage disassembly and reduce panel removals minimize the number of panel fasteners or preferably utilize latches rather than screws/fasteners.

Eliminate elaborate checkout procedures which require extensive graphical plotting and subsequent comparison to template curves. Rigging and Operational checks should be straightforward and simple.

TABLE 6.24 MAINTENANCE DATA - INBOARD LEADING EDGE FLAPS

WORK UNIT CODES

A-4	N/A	A-6	14814	A-7	14710	AV-8	N/A	F-4	14510
F-8	14611	F-14	14611	P-3	N/A	S-3	14722		

ORGANIZATIONAL LEVEL

A/C	FLIGHT HOURS	MFHBMA	MA/FH X10-3	MTTR	MMH/MA	MEN/MA	MMH/FH	R+R	O+I MTBF
A-4M	35,571								
A-6E	87,564	218.9	4.6	3.48	7.54	2.2	.034	5.89	284
A-7E	159,611	436.1	2.3	3.36	6.65	2.0	.015	10.32	545
AV-8A	19,396								
F-4J	115,070	130.5	7.7	2.26	4.08	1.8	.031	10.62	209
F-8J	18,317	339.2	2.9	2.45	5.87	2.4	.017		796
F-14A	51,286	233.1	4.3	1.84	3.39	1.8	.015	3.12	296
P-3C	125,860								
S-3A	60,552	796.7	1.3	2.82	5.35	1.9	.007	0.70	1,442

INTERMEDIATE LEVEL

A/C	FLIGHT HOURS	MFHBMA	MA/FH X10-3	MTTR	MMH/MA	MEN/MA	MMH/FH
A-4M	35,571						
A-6E	87,564	3,807.1	0.3	7.60	11.02	1.4	.003
A-7E	159,611	7,600.5	0.1	5.91	6.71	1.1	.001
AV-8A	19,396						
F-4J	115,070	8,851.5	0.1	5.50	5.88	1.1	.001
F-8J	18,317	18,317.0	0.1	0.50	0.50	1.0	.000
F-14A	51,286	51,286.0	0.0	1.00	1.00	1.0	.000
P-3C	125,860						
S-3A	60,552						

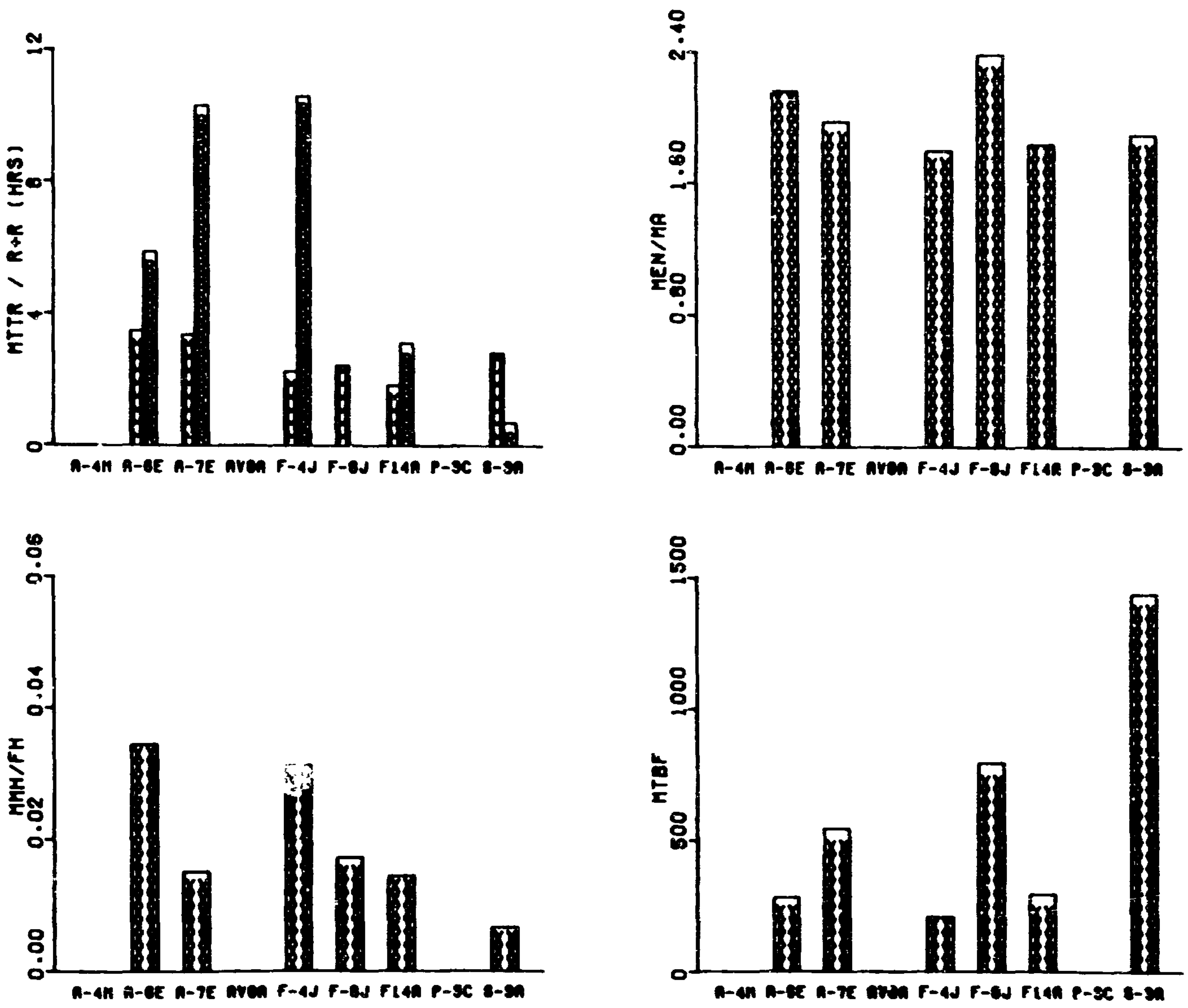


FIGURE 6.24 SELECTED GRAPHICAL DATA - INBOARD LEADING EDGE FLAPS

6.7.8 Inboard Leading Edge Flaps (See preceding Table and Figure 6.24)

WORK UNIT CODES

A-4 N/A	A-6 14814	A-7 14710	AV-8 N/A	F-4 14510
F-8 14611	F-14 14611	P-3 N/A	S-3 14722	

DISCUSSION

Comments:

The leading edges employ several types of actuating devices: hinges with actuators, actuators with slats, and jackscrews. The method of actuation dictates the flap installation which in turn drives maintenance expenditures. The jackscrew and track arrangement on the F-14A, although requiring quite a few bolts to be removed, is simple and this simplicity is reflected in all the F-14A 3-M maintenance parameters. The F-4J leading flap installation differs from the other installations surveyed in that the actuator is in the leading edge itself rather than the wing. Review of the 3-M data indicates that this design technique adds considerable time to repair actions because actuator connections as well as the flap must be disconnected from the wing. Requiring critical aerodynamic seal clearances as on the A-7E will drive maintenance rates up. Double droop leading edges as used in the F-8J are complex and can be expected to be a major maintenance burden. The S-3A and F-8J quantitative sample sizes, for removal data one and zero respectively, are too small to be held as representative average replacement times.

Recommendations:

When electrical cable disconnections are required, plugs should be employed. Cutting and splicing of wires is not acceptable under any circumstances for this type of installation.

Aerodynamic seals, when used, should not require exacting tolerances, special tools, or be easily susceptable to damage during installation.

Eliminate attachment hardware peculiarities. All nuts and bolts for a particular type installation, e.g. track bolt connections, should be interchangeable.

TABLE 6.25 MAINTENANCE DATA - OUTBOARD LEADING EDGE FLAPS

WORK UNIT CODES

A-4	N/A	A-6	N/A	A-7	14720	AV-8	N/A	F-4	N/A
F-8	14612	F-14	14612	P-3	N/A	S-3	N/A		

ORGANIZATIONAL LEVEL

A/C	FLIGHT HOURS	MFHBMA	MA/FH X10-3	MTTR	MMH/MA	MEN/MA	MMH/FH	R+R	O+I MTBF
A-4M	35,571								
A-6E	87,564								
A-7E	159,611	430.2	2.3	3.61	7.68	2.1	.018	12.46	545
AV-8A	19,396								
F-4J	115,070								
F-8J	18,317	482.0	2.1	4.17	10.15	2.4	.021	7.50	1,018
F-14A	51,286	1,192.7	0.8	2.96	6.29	2.1	.005	9.86	2,564
P-3C	125,860								
S-3A	60,552								

INTERMEDIATE LEVEL

A/C	FLIGHT HOURS	MFHBMA	MA/FH X10-3	MTTR	MMH/MA	MEN/MA	MMH/FH
A-4M	35,571						
A-6E	87,564						
A-7E	159,611	6,939.6	0.1	5.12	8.35	1.6	.001
AV-8A	19,396						
F-4J	115,070						
F-8J	18,317	6,105.7	0.2	1.00	1.50	1.5	.000
F-14A	51,286	25,643.0	0.0	1.75	1.75	1.0	.000
P-3C	125,860						
S-3A	60,552						

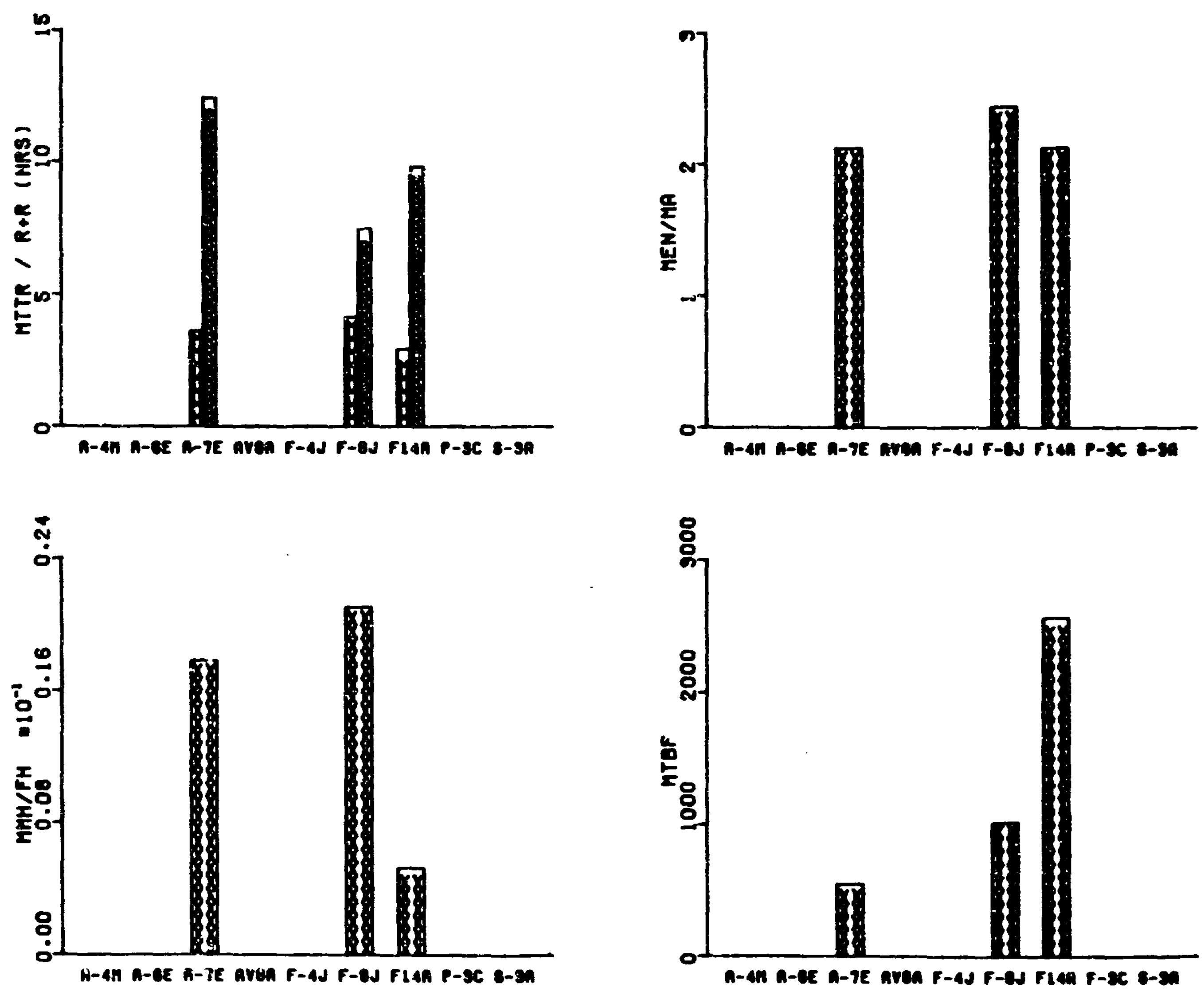


FIGURE 6.25 SELECTED GRAPHICAL DATA - OUTBOARD LEADING EDGE FLAPS

6.7.9 Outboard Leading Edge Flaps (See preceding Table and Figure 6.25)

WORK UNIT CODES

A-4 N/A	A-6 N/A	A-7 14720	AV-8 N/A	F-4 N/A
F-8 14612	F-14 14612	P-3 N/A	S-3 N/A	

DISCUSSION

<u>Comments</u>:

Only three outboard leading edge flaps were evaluated. The F-8J data sample for R+R is too small (two) to make that data element statistically accurate. Both inboard and outboard F-14A leading edge flaps come off together and are later separated. Comparison of the quantitative data on the F-14A shows a 60 percent to 215 percent difference between inboard and outboard flap maintenance parameters in an installation which is essentially the same as far as replacement is concerned. Very little in the way of explanation can be offered for the differences. One possible explanation may be the difference in data sample size and the inherent smoothing effect a larger base has. The inboard flap had 220 overall maintenance actions with 22 removals, the outboard 38 and 5 respectively. The A-7E outboard flap attachment points are more difficult to work around than similar attachment points on the inboard flap, hence a slightly greater maintenance expenditure than the inboard flap experienced.

<u>Recommendations</u>:

When electrical cable disconnections are required, plugs should be employed. Cutting and splicing of wires is not acceptable under any circumstances for this type of installation.

Aerodynamic seals, when used, should not require exacting tolerances, special tools, or be easily susceptable to damage during installation.

Eliminate attachment hardware peculiarities. All nuts and bolts for a particular type installation, e.g. track bolt connections, should be interchangeable.

TABLE 6.26 MAINTENANCE DATA - TRAILING EDGE FLAPS

WORK UNIT CODES

A-4	14511	A-6	N/A	A-7	14730	AV-8	14510	F-4	14540
F-8	1471A	F-14	14614	P-3	1491L	S-3	1481C		

ORGANIZATIONAL LEVEL

A/C	FLIGHT HOURS	MFHBMA	MA/FH X10-3	MTTR	MMH/MA	MEN/MA	MMH/FH	R+R	O+I MTBF
A-4M	35,571	1,016.3	1.0	2.96	6.07	2.1	.006	4.60	1,872
A-6E	87,564								
A-7E	159,611	246.7	4.1	2.69	5.30	2.0	.021	6.16	39[illegible]
AV-8A	19,396	192.0	5.2	2.67	5.01	1.9	.026	5.00	431
F-4J	115,070	67.3	14.9	3.41	7.07	2.1	.105	10.34	96
F-8J	18,317	482.0	2.1	2.92	5.06	1.7	.010	10.00	591
F-14A	51,286	603.4	1.7	2.93	5.85	2.0	.010	5.92	950
P-3C	125,860	115.3	8.7	1.99	3.75	1.9	.033	28.00	193
S-3A	60,552	1,009.2	1.0	5.86	10.05	1.7	.010	6.00	1,442

INTERMEDIATE LEVEL

A/C	FLIGHT HOURS	MFHBMA	MA/FH X10-3	MTTR	MMH/MA	MEN/MA	MMH/FH
A-4M	35,571	7,114.2	0.1	0.54	0.54	1.0	.000
A-6E	87,564						
A-7E	159,611	4,987.8	0.2	4.90	6.61	1.3	.001
AV-8A	19,396	2,770.9	0.4	11.31	15.49	1.4	.006
F-4J	115,070	865.2	1.2	5.64	7.12	1.3	.008
F-8J	18,317	9,158.5	0.1	1.90	1.90	1.0	.000
F-14A	51,286	8,547.7	0.1	8.17	14.17	1.7	.002
P-3C	125,860	15,732.5	0.1	14.60	18.76	1.3	.001
S-3A	60,552	8,650.3	0.1	19.93	32.21	1.6	.004

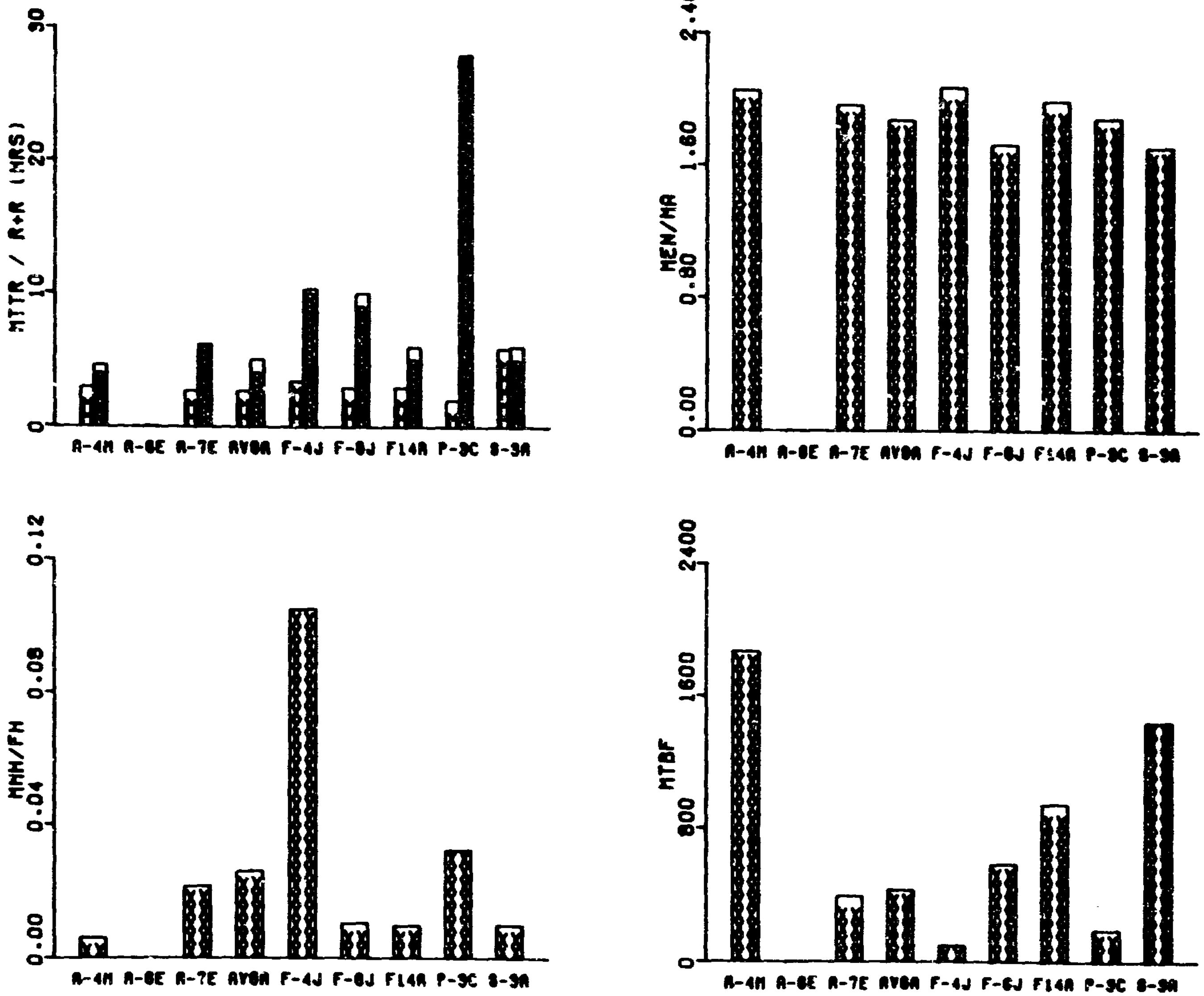


FIGURE 6.26 SELECTED GRAPHICAL DATA - TRAILING EDGE FLAPS

6.7.10 Trailing Edge Flaps (See preceding Table and Figure 6.26)

WORK UNIT CODES

A-4 .4511	A-6 N/A	A-7 14730	AV-8 14510	F-4 14540
F-8 1471A	F-14 14614	P-3 1491L	S-3 1481C	

DISCUSSION

Comments:

Except for the F-4J, the trailing edge flaps have experienced many general repairs and few replacements. The F-8J and P-3C have had only one replacement in eighteen months, while the A-4M, A-7E, AV-8A, F-14A, and S-3A chalked up between four and six removals. Although sufficient data exists for the remainder of the data elements presented, the qualitative information contained in References 6 and 21 concerns procedures for removal and installation; and, that sample size, with the exception of the F-4J, is too small for valid comparisons. The F-4J R+R time is high considering its low MTBF. Panels are secured with copious quantities of fasteners and even after they are removed, hydraulic manipulation of the flap is required to improve accessibility. Boundary layer control (BLC) components and a rocket launcher require disassembly or removal thereby adding to flap replacement maintenance expenditures. Physical size and weight as in the P-3C flap, can be expected to have a measurable impact on maintenance parameters. Likewise, inclusion of BLC in wing designs will also show up as added maintenance time for the trailing edge flaps.

Recommendations:

Avoid removal of unassociated equipment when performing maintenance on the trailing edge flaps.

Ground support equipment to perform rigging and operational checks should be minimized.

TABLE 6.27 MAINTENANCE DATA - AILERON

WORK UNIT CODES

A-4 14211 14212 A-6 N/A A-7 14220 AV-8 14110 F-4
14210 F-8 14211 14212 F-14 N/A P-3 1421A S-3 14328

ORGANIZATIONAL LEVEL

A/C	FLIGHT HOURS	MFHBMA	MA/FH X10-3	MTTR	MMH/MA	MEN/MA	MMH/FH	R+R	O+I MTBF
A-4M	35,571	140.0	7.1	1.78	3.04	1.7	.022	2.48	229
A-6E	87,564								
A-7E	159,611	560.0	1.8	2.08	3.92	1.9	.007	4.81	779
AV-8A	19,396	373.0	2.7	2.59	5.04	1.9	.014	8.50	524
F-4J	115,070	68.3	14.6	3.46	7.22	2.1	.106	6.63	103
F-8J	18,317	86.8	11.5	4.04	8.74	2.2	.101	6.80	110
F-14A	51,286								
P-3C	125,860	715.1	1.4	2.11	4.06	1.9	.006	12.30	912
S-3A	60,552	680.4	1.5	2.42	3.98	1.6	.006		865

INTERMEDIATE LEVEL

A/C	FLIGHT HOURS	MFHBMA	MA/FH X10-3	MTTR	MMH/MA	MEN/MA	MMH/FH
A-4M	35,571	613.3	1.6	5.07	5.95	1.2	.010
A-6E	87,564						
A-7E	159,611	17,734.6	0.1	5.27	6.00	1.1	.000
AV-8A	19,396	19,396.0	0.1	3.20	6.50	2.0	.000
F-4J	115,070	728.3	1.4	10.39	17.34	1.7	.024
F-8J	18,317	254.4	3.9	28.75	43.73	1.5	.172
F-14A	51,286						
P-3C	125,860	31,465.0	0.0	35.05	38.80	1.1	.001
S-3A	60,552						

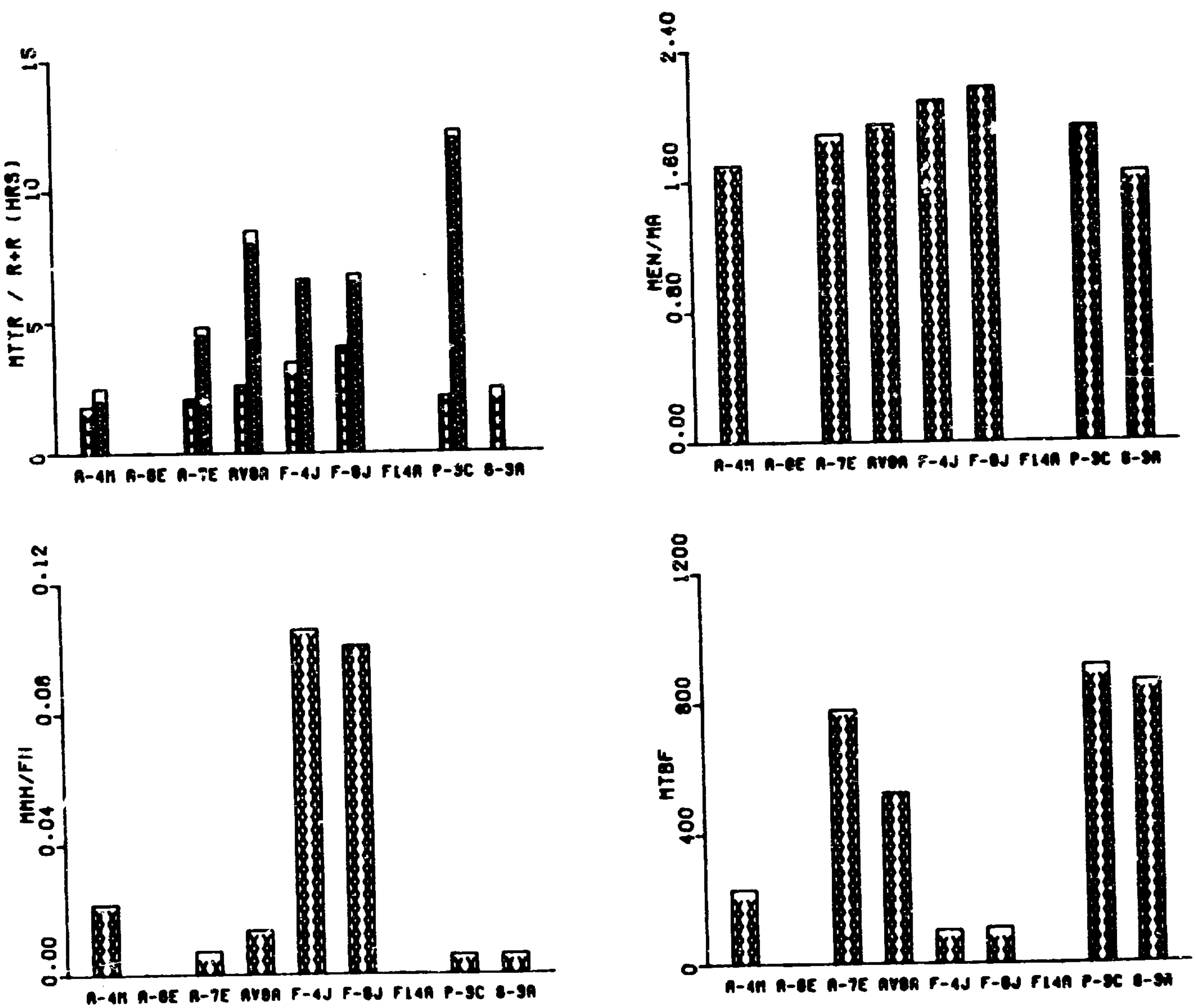


FIGURE 6.27 SELECTED GRAPHICAL DATA - AILERON

6.7.11 Aileron (See preceding Table and Figure 6.27)

WORK UNIT CODES

A-4 14211, 14212	A-6 N/A	A-7 14220	AV-8 14110	F-4 14210
F-8 14211, 14212	F-14 N/A	P-3 1421A	S-3 14328	

DISCUSSION

Comments:

Like other flight control surfaces, the aileron is worked on frequently but removal is a fairly rare occasion, except on the F-4J. Only two removals occurred on the P-3C which would normally make the average R+R time statistically suspect. However, because the P-3C aileron requires the entire wing tip be removed, the replacement time is considered to be a representative guage of effort needed to perform the task. The low wing design and simple removal tasks of the A-4M aileron installation are echoed in the maintenance rates. The low maintenance rates of the A-4M reflect about twice as many left hand (WUC 14212) removals than right. Manipulation of an excessive number of panel fasteners help push the A-7E higher than should be necessary. Removal samples for the AV-8A and S-3A are too small to be statistically representative.

Recommendations:

Removal of structure other than the item failed is not acceptable. Disruption of unassociated equipment should be avoided.

Optimize the quantity and size of panels which require removal to accomplish a task and minimize the number of fasteners involved. Whenever possible utilize latches rather than screws/fasteners.

TABLE 6.28 MAINTENANCE DATA - RUDDER

WORK UNIT CODES

A-4	14711	A-6	N/A	A-7	14410	AV-8	14210	F-4	14410
F-8	14312	F-14	14311	P-3	N/A	S-3	N/A		

ORGANIZATIONAL LEVEL

A/C	FLIGHT HOURS	MFHBMA	MA/FH X10-3	MTTR	MMH/MA	MEN/MA	MMH/FH	R+R	O+I MTBF
A-4M	35,571	2,223.2	0.4	0.93	1.21	1.3	.001		3,234
A-6E	87,564								
A-7E	159,611	345.5	2.9	3.58	7.00	2.0	.020	5.39	423
AV-8A	19,396	103.2	9.7	2.61	4.02	1.5	.039	2.35	234
F-4J	115,070	174.3	5.7	3.94	8.57	2.2	.049	13.33	219
F-8J	18,317	436.1	2.3	3.29	7.10	2.2	.016		482
F-14A	51,286	483.8	2.1	5.07	10.91	2.2	.023	7.00	900
P-3C	125,860								
S-3A	60,552								

INTERMEDIATE LEVEL

A/C	FLIGHT HOURS	MFHBMA	MA/FH X10-3	MTTR	MMH/MA	MEN/MA	MMH/FH
A-4M	35,571	35,571.0	0.0	0.50	0.50	1.0	.000
A-6E	87,564						
A-7E	159,611	10,640.7	0.1	12.56	21.76	1.7	.002
AV-8A	19,396	2,155.1	0.5	3.47	3.69	1.1	.002
F-4J	115,070	2,557.1	0.4	3.49	4.24	1.2	.002
F-8J	18,317						
F-14A	51,286	25,643.0	0.0	13.50	27.00	2.0	.001
P-3C	125,860						
S-3A	60,552						

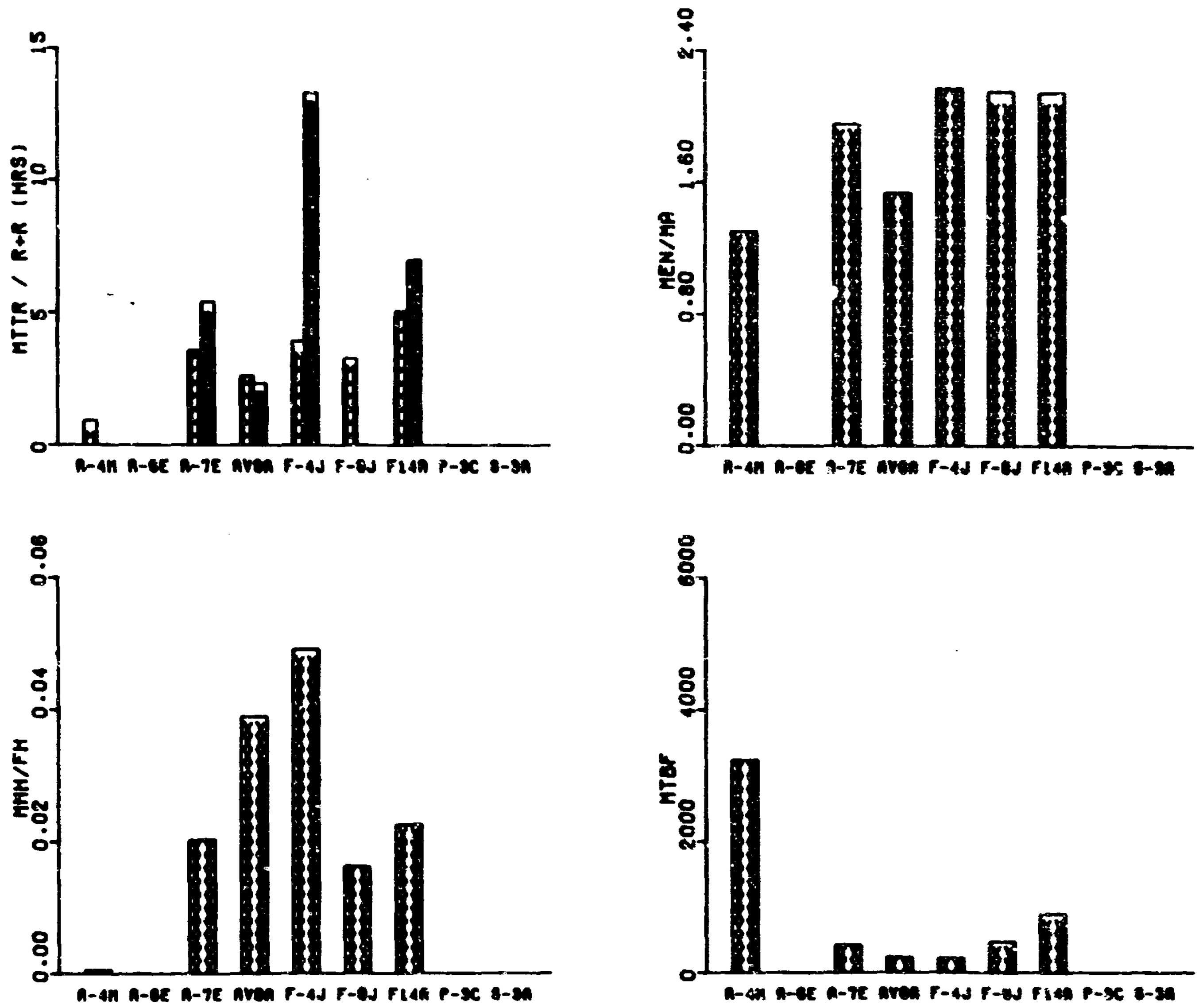


FIGURE 6.28 SELECTED GRAPHICAL DATA - RUDDER

6.7.12 Rudder (See preceding Table and Figure 6.28)

WORK UNIT CODES

A-4 14711	A-6 N/A	A-7 14410	AV-8 14210	F-4 14410
F-8 14312	F-14 14311	P-3 N/A	S-3 N/A	

DISCUSSION

Comments:

In general rudder assemblies reviewed are simple to remove once access and any disassembly has been accomplished. The differences in the quantitative values relate almost entirely to gaining access and to subsequent operational checks. No removals, high MTBF, and the lowest maintenance parameters of any aircraft surveyed attest to the reliability and the simple maintenance tasks of the A-4M rudder. Virtually no access requirements and only hinge and actuator connection bolts, all in plain view, enable technicians to perform maintenance on the A-4M rudder quickly. The AV-8A rudder, which experienced the lowest R+R of the aircraft reviewed, is mechanically actuated through a linkage from the yaw nozzle. This allows operational checks to be made in far less time than corresponding hydraulically powered rudders, which require external power sources and added time to connect and operate the source. Excessive quantities of fasteners, much disassembly in the rudder area, field build-up of the replacement rudder, and handling the rudder weight assembly as a separate entity from the rudder combine to make the removal and installation of the F-4J the most costly maintenance-wise. Removal data on the A-4M, F-14A and F-8J is not representative of the actual task due to the small sample sizes.

Recommendations:

Removal tasks for this component should be kept simple with a minimum amount of disassembly.

Ensure hinge bolts have sufficient clearance near the skin surface for ease of removal.

Eliminate the requirement for field build-up of replacement rudders. Rudders should come from supply ready to install.

Reduce the quantity of fasteners requiring removal to gain access. This reduction can be affected by utilizing one or more of the following techniques: use hinged doors with quick release latches, use quick release fasteners instead of screws or break large surface panels into several smaller ones which are held in place with quick release fasteners.

TABLE 6.29 MAINTENANCE DATA - SPOILER ASSEMBLY

WORK UNIT CODES

A-4	14A11	A-6	N/A	A-7	14311	AV-8	N/A	F-4	14240
F-8	N/A	F-14	14211	P-3	N/A	S-3	N/A		

ORGANIZATIONAL LEVEL

A/C	FLIGHT HOURS	MFHBMA	MA/FH X10-3	MTTR	MMH/MA	MEN/MA	MMH/FH	R+R	O+I MTBF
A-4M	35,571	1,546.6	0.6	2.93	5.57	1.9	.004	6.38	4,446
A-6E	87,564								
A-7E	159,611	1,612.2	0.6	2.81	5.23	1.9	.003	5.83	3,325
AV-8A	19,396								
F-4J	115,070	349.8	2.9	2.39	4.52	1.9	.013	5.74	521
F-8J	18,317								
F-14A	51,286	1,114.9	0.9	4.18	9.38	2.2	.008		2,564
P-3C	125,860								
S-3A	60,552								

INTERMEDIATE LEVEL

A/C	FLIGHT HOURS	MFHBMA	MA/FH X10-3	MTTR	MMH/MA	MEN/MA	MMH/FH
A-4M	35,571	8,892.8	0.1	1.10	1.10	1.0	.000
A-6E	87,564						
A-7E	159,611	5,503.8	0.2	13.78	17.62	1.3	.003
AV-8A	19,396						
F-4J	115,070	4,109.6	0.2	1.95	2.35	1.2	.001
F-8J	18,317						
F-14A	51,286	25,643.0	0.0	3.00	5.50	1.8	.000
P-3C	125,860						
S-3A	60,552						

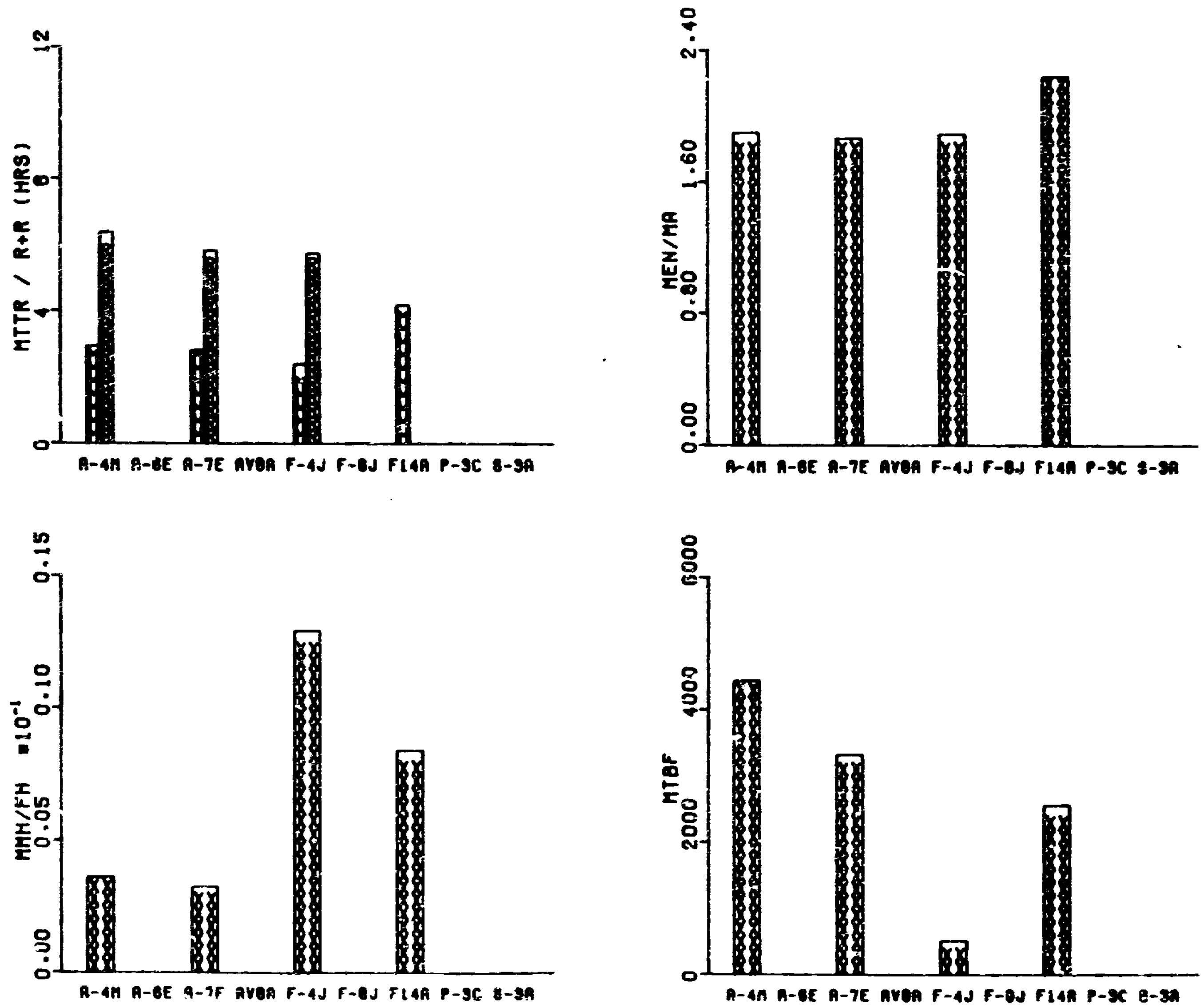


FIGURE 6.29 SELECTED GRAPHICAL DATA - SPOILER ASSEMBLY

6.7.13 Spoiler Assembly (See *preceding Table and Figure 6.29*)

WORK UNIT CODES

A-4 14A11	A-6 N/A	A-7 14311	AV-8 N/A	F-4 1424C
F-8 N/A	F-14 14211	P-3 N/A	S-3 N/A	

DISCUSSION

Comments:

Quantitatively very little difference exists in the replacement times reported by 3-M between the installations surveyed. Qualitatively, three of the installations (A-4M, F-4J, F-14A) employ hinge pins to attach the spoiler to the wing while the fourth (A-7E) uses a hinge and bolt arrangement. Analysis of the qualitative information from the Qualitative Maintenance Experience Handbook would indicate the hinge pin designs are simpler in their maintenance tasks than hinge and bolt arrangements and would therefore be more preferable from a maintenance viewpoint. The F-14A experienced no removals thus invalidating the R+R time. However, the F-14A's MTTR and MMH/FH which is based on 46 maintenance actions run considerably higher than the other three aircraft. In order to perform spoiler maintenance, the aircraft must be re-spotted in an area which allows the technician to spread the wings to 20 feet. These movements account for part of the extra expended time and additional personnel.

Recommendations:

Avoid transferance of components from one spoiler to another or any other field build-up. Where linkage transferance is unavoidable, linkages should be interchangeable to prevent "Murphyism".

Ensure provisions for adequate corrosion prevention and lubrication are provided in hinge pin designs. Corroded or stuck pins negate the simplicity of maintenance tasks which go with them.

Eliminate any requirements to move wings or other open surfaces beside the spoiler. Designs which deploy the spoiler for access should be able to do so under hand pump pressure only.

TABLE 6.30 MAINTENANCE DATA - PILOT'S STICK ASSEMBLY

WORK UNIT CODES

A-4	N/A	A-6	14211	A-7	14111	AV-8	14411	F-4	14111
F-8	14111	F-14	5771A	P-3	N/A	S-3	5736A		

ORGANIZATIONAL LEVEL

A/C	FLIGHT HOURS	MFHBMA	MA/FH X10-3	MTTR	MMH/MA	MEN/MA	MMH/FH	R+R	O+I MTBF
A-4M	35,571								
A-6E	87,564	353.1	2.8	2.40	4.06	1.7	.012	4.79	730
A-7E	159,611	298.3	3.4	1.28	1.98	1.6	.007	1.91	706
AV-8A	19,396	843.3	1.2	2.06	3.17	1.5	.004	4.75	3,879
F-4J	115,070	411.0	2.4	1.51	2.64	1.8	.006	2.55	1,535
F-8J	18,317	229.0	4.4	1.47	5.31	3.6	.023	7.50	1,221
F-14A	51,286	51,286.0	0.0	0.50	0.50	1.0	.000	2.78	51,286
P-3C	125,860								
S-3A	60,552	550.5	1.8	2.61	4.02	1.5	.007	5.29	2,329

INTERMEDIATE LEVEL

A/C	FLIGHT HOURS	MFHBMA	MA/FH X10-3	MTTR	MMH/MA	MEN/MA	MMH/FH
A-4M	35,571						
A-6E	87,564	1,751.3	0.6	2.93	5.64	1.9	.003
A-7E	159,611	862.8	1.2	3.63	3.92	1.1	.005
AV-8A	19,396	1,492.0	0.7	1.55	2.15	1.4	.001
F-4J	115,070	2,301.4	0.4	3.27	4.39	1.3	.002
F-8J	18,317	3,663.4	0.3	4.00	4.40	1.1	.001
F-14A	51,286						
P-3C	125,860						
S-3A	60,552	2,162.6	0.5	2.02	2.27	1.1	.001

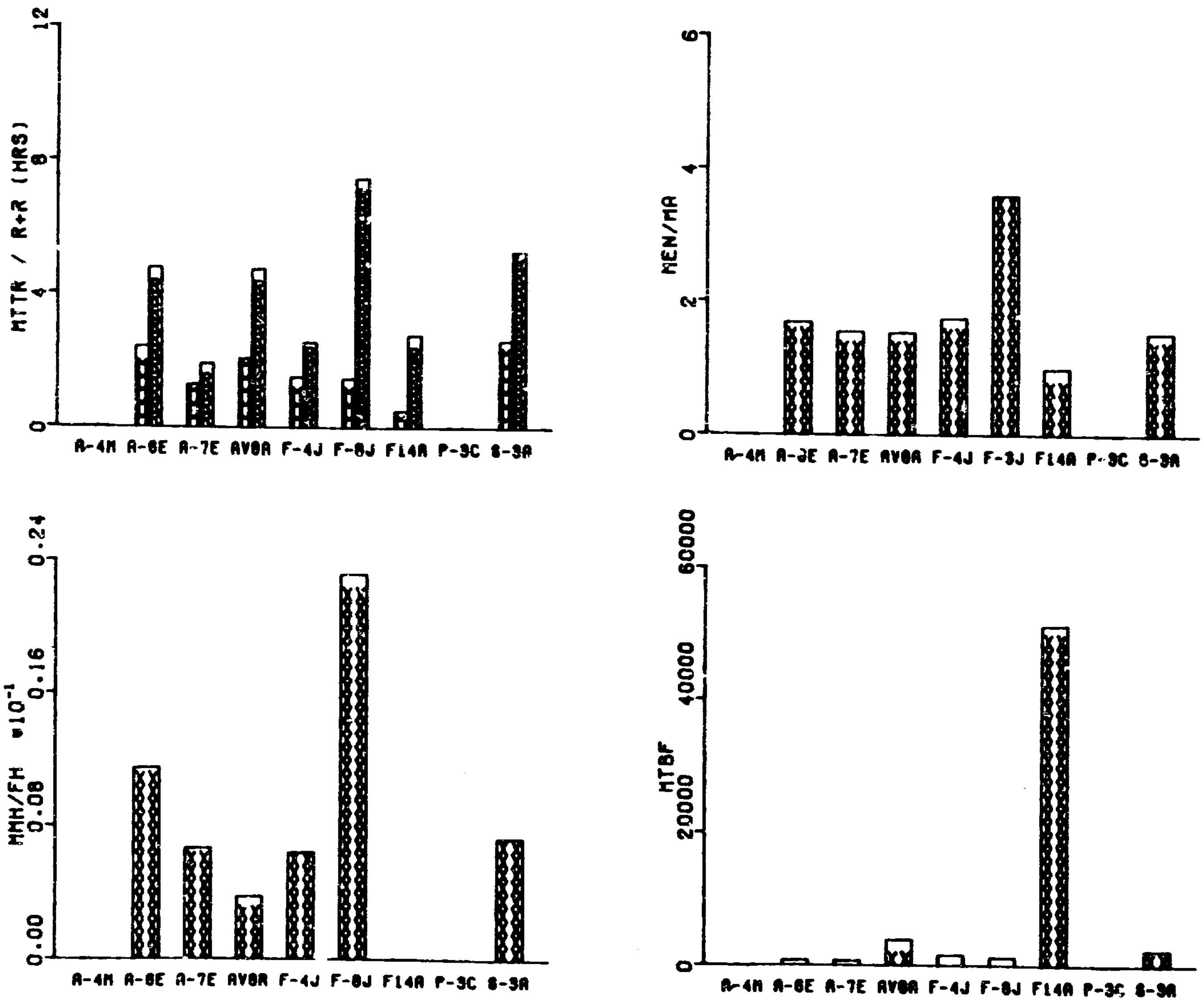


FIGURE 6.30 SELECTED GRAPHICAL DATA - PILOT'S STICK ASSEMBLY

6.7.14 Pilot's Stick Assembly (See preceding Table and Figure 6.30)

WORK UNIT CODES

A-4 N/A	A-6 14211	A-7 14111	AV-8 14411	F-4 14111
F-8 14111	F-14 5771A	P-3 N/A	S-3 5736A	

DISCUSSION

Comments:

Qualitatively, all seven control sticks evaluated required essentially the same effort. The A-7E, F-4J, and F-14A are the simplest, requiring loosening of three set screws. The electrical connections are made along with the physical via a plug in control stick. The remainder of the aircraft utilize a single bolt arrangement with electrical connectors. The differences between aircraft in the quantitative 3-M values are due to the quantity of and the relative ease in performing after installation checks. Pilot's stick assemblies in modern aircraft provide for many functions within the reach of the pilot's fingers. They also provide a means for control for the flight surfaces. Because of the versatility of the pilots stick, many functions/systems are disturbed when the stick is removed. Upon installation, these systems require checking to ensure the new pilot's stick performs properly. Some sticks have more functions hence more checks; and some checks take longer than others. The qualitative material available for this analysis did not evaluate efficiency of operational checks.

Recommendations:

System checks required upon installation should be automated as much as possible. Designs should make extensive use of self test, BIT, and BITE.

When electrical connections are made with electrical connectors, as opposed to plug in sticks, care should be given to cable routing to prevent subsequent damage.

TABLE 6.31 MAINTENANCE DATA - APPROACH POWER COMPUTER

WORK UNIT CODES

A-4	N/A	A-6	N/A	A-7	29C26	AV-8	N/A	F-4	29C1N
F-8	29C73	F-14	29C31	P-3	N/A	S-3	N/A		

ORGANIZATIONAL LEVEL

A/C	FLIGHT HOURS	MFHBMA	MA/FH X10-3	MTTR	MMH/MA	MEN/MA	MMH/FH	R+R	O+I MTBF
A-4M	35,571								
A-6E	87,564								
A-7E	159,611	175.4	5.7	1.33	2.67	2.0	.015	2.16	228
AV-8A	19,396								
F-4J	115,070	347.6	2.9	2.92	6.32	2.2	.018	4.75	466
F-8J	18,317	28.7	34.9	1.43	2.66	1.9	.093	2.17	33
F-14A	51,286	72.3	13.8	1.59	3.48	2.2	.048	2.30	187
P-3C	125,860								
S-3A	60,552								

INTERMEDIATE LEVEL

A/C	FLIGHT HOURS	MFHBMA	MA/FH X10-3	MTTR	MMH/MA	MEN/MA	MMH/FH
A-4M	35,571						
A-6E	87,564						
A-7E	159,611	763.7	1.3	5.91	6.90	1.2	.009
AV-8A	19,396						
F-4J	115,070	1,027.4	1.0	4.68	6.20	1.3	.006
F-8J	18,317	72.4	13.8	3.85	4.79	1.2	.066
F-14A	51,286	126.9	7.9	4.78	6.99	1.5	.055
P-3C	125,860						
S-3A	60,552						

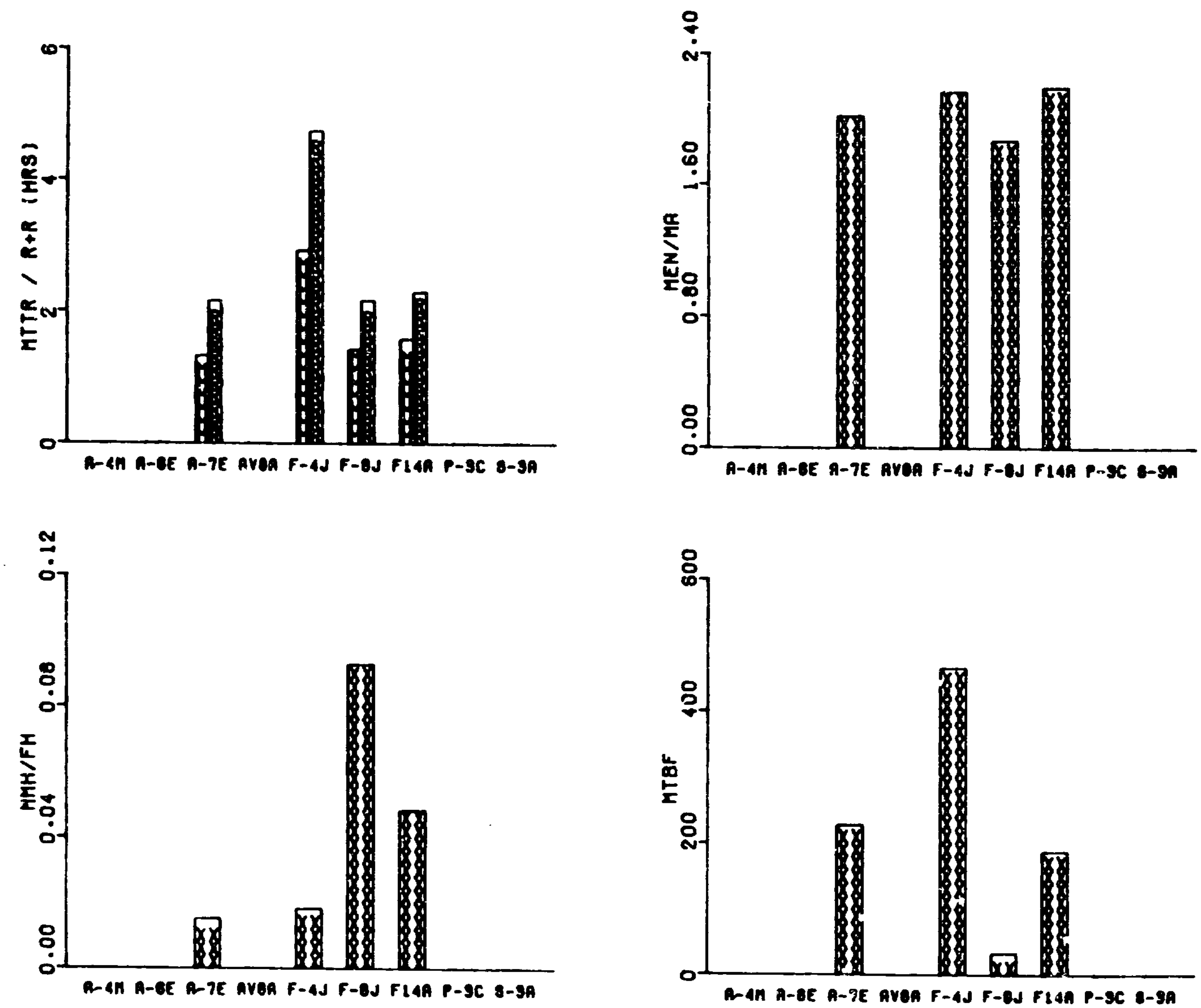


FIGURE 6.31 SELECTED GRAPHICAL DATA - APPROACH POWER COMPUTER

6.8 POWER PLANT INSTALLATION

6.8.1 Approach Power Computer (See preceding Table and Figure 6.31)

WORK UNIT CODES

A-4 N/A	A-6 N/A	A-7 29C26	AV-8 N/A	F-4 29C1N
F-8 29C73	F-14 29C31	P-3 N/A	S-3 N/A	

DISCUSSION

<u>Comments</u>:

On all aircraft, the approach power computers remove simply, requiring one electrical disconnection and removal of one to four bolts. The difference in the quantitative values is due, in large part, to access and operational checks. The F-4J approach power computer generates the greatest maintenance burden because the aft ejection seat must be removed to gain access to the black box. On the other hand, the F-8J computer is in a wheel well providing immediate access, a feature strongly needed considering its low MTBF. Methods of operationally testing the computer vary and should show a substantial impact on the R+R time, but do not. The A-7E and F-4J require undesirable engine runs, the F-8J a voltage check, and the F-14A, a preferred self-test. It is believed that the time required for the engine run is not reflected in the data; that it is either deferred to another time, showing up under a different code, or accomplished during the next scheduled flight. The advantage of the F-14A self test is somewhat negated by difficulty removing two of the four mounting bolts because of obstructions.

<u>Recommendations</u>:

Utilize self-test or BIT on the approach power computers. Operationally checking the unit by engine run is unacceptable, time consuming, and very costly.

Eliminate requirements to remove unassociated equipment to gain access or facilitate maintenance.

Ensure sufficient room is given for hand and tool room on mountings. Employ quick release hold downs to secure equipment vice bolts.

TABLE 6.32 MAINTENANCE DATA - THROTTLE QUADRANT

WORK UNIT CODES

A-4	29315	A-6	29313	A-7	29311	AV-8	29117	F-4	29313
F-8	29310	F-14	29322	P-3	N/A	S-3	N/A		

ORGANIZATIONAL LEVEL

A/C	FLIGHT HOURS	MFHBMA	MA/FH X10-3	MTTR	MMH/MA	MEN/MA	MMH/FH	R+R	O+I MTBF
A-4M	35,571	1,317.4	0.8	2.83	5.16	1.8	.004		2,736
A-6E	87,564	278.0	3.6	4.61	8.39	1.8	.030	6.62	584
A-7E	159,611	593.3	1.7	1.43	2.59	1.8	.004	13.25	1,308
AV-8A	19,396	2,770.9	0.4	5.21	9.71	1.9	.004		3,879
F-4J	115,070	192.1	5.2	3.21	7.04	2.2	.037	5.03	358
F-8J	18,317	105.3	9.5	1.78	3.50	2.0	.033		165
F-14A	51,286	172.1	5.8	5.08	10.29	2.0	.060	10.09	395
P-3C	125,860								
S-3A	60,552								

INTERMEDIATE LEVEL

A/C	FLIGHT HOURS	MFHBMA	MA/FH X10-3	MTTR	MMH/MA	MEN/MA	MMH/FH
A-4M	35,571	35,571.0	0.0	1.50	2.50	1.7	.000
A-6E	87,564	742.1	1.3	3.60	5.15	1.4	.007
A-7E	159,611	53,203.7	0.0	3.43	7.10	2.1	.000
AV-8A	19,396						
F-4J	115,070	532.7	1.9	1.11	1.52	1.4	.003
F-8J	18,317	18,317.0	0.1	4.00	4.00	1.0	.000
F-14A	51,286	1,424.6	0.7	6.78	8.80	1.3	.006
P-3C	125,860						
S-3A	60,552						

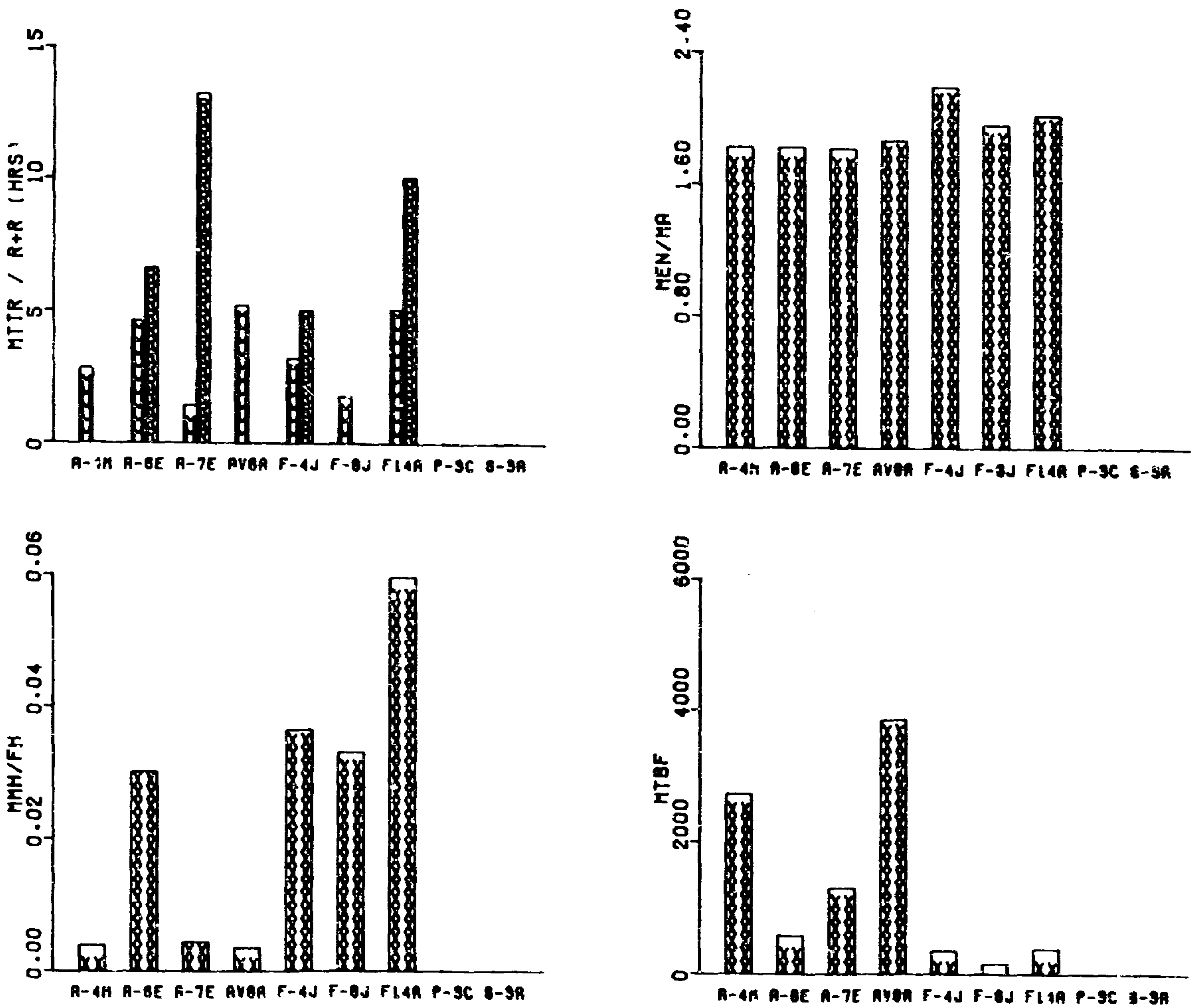


FIGURE 6.32 SELECTED GRAPHICAL DATA - THROTTLE QUADRANT

6.8.2 Throttle Quadrant (See preceding Table and Figure 6.32)

WORK UNIT CODES

A-4 29315	A-6 29313	A-7 29311	AV-8 29117	F-4 29313
F-8 29310	F-14 29322	P-3 N/A	S-3 N/A	

DISCUSSION

Comments:

Three of the seven aircraft surveyed (A-4M, AV-8A, and F-8J) required repairs to the throttle quadrant but not to the extent that any removals occurred. The A-7E also had a considerable number of repairs yet experienced just two removals. As such, the R+R times for these four aircraft are statistically non-representative of a typical replacement action. Nonetheless, all the throttle quadrants require extensive disassembly of the cockpit and are difficult to work on. Removal of a well fastened console access panel, adjacent control boxes, linkages, bellcranks, and electrical disconnections, as well as the throttle mountings, make this a complex installation. Although the A-7E R+R time is not representative, removal of three adjacent control panels to gain access to the quadrant is a feature, which if emulated, cannot but add unnecessary maintenance expense to the throttle quadrant through the sometimes lengthy functional checks of these other panels. Seat and canopy removal required in the F-14A has driven all of the F-14A maintenance parameters up. The F-4J quantitative value for R+R time is the lowest; however, its installation is comparable to others in complexity and difficulty. A possible explanation for the low time may be due to technician familiarity with the job. There were 266 removals in the time frame covered. The low A-6E R+R time is due in part to one of the simplest installations and again possible mechanic familiarity with the job (130 removals). The A-6E seat and canopy have to be removed to accomplish the task.

Recommendations:

Modern cockpit design more and more involves high density packaging. As more functions are added to the throttle handle, to help ease pilot workload, strong maintainability features become more important.

Minimize the size of console side access panels. Several smaller panels with few fasteners covering specific work areas are preferred over long, well fastened console length panels.

Eliminate any requirement for ejection seat/canopy removal to replace the throttle quadrant or for that matter any cockpit equipment.

Avoid removal or displacement of adjacent control boxes or panels. Disruption of these systems requires subsequent checkouts, generally time consuming.

Utilize BITE to perform as many of the post installation checks as possible. Engine operation may be necessary but innovative designs should be able to check linkage operation without costly, time consuming engine runs.

TABLE 6.33 MAINTENANCE DATA - CABIN TEMP CONTROL

WORK UNIT CODES

A-4	41126	A-6	N/A	A-7	41134	AV-8	41126	F-4	4111J
F-8	N/A	F-14	41152	P-3	41156	S-3	4113F		

ORGANIZATIONAL LEVEL

A/C	FLIGHT HOURS	MFHBMA	MA/FH X10-3	MTTR	MMH/MA	MEN/MA	MMH/FH	R+R	O+I MTBF
A-4M	35,571	1,226.6	0.8	3.63	5.53	1.5	.005	14.15	4,446
A-6E	87,564								
A-7E	159,611	362.8	2.8	2.28	3.49	1.5	.010	3.12	1,017
AV-8A	19,396	346.4	2.9	2.14	3.42	1.6	.010	2.09	776
F-4J	115,070	1,555.0	0.6	1.06	1.57	1.5	.001	3.05	8,219
F-8J	18,317								
F-14A	51,286	576.2	1.7	2.06	4.29	2.1	.007	5.74	1,899
P-3C	125,860	1,057.6	0.9	1.06	1.53	1.4	.001	1.52	2,997
S-3A	60,552	469.4	2.1	1.55	2.40	1.6	.005	3.03	1,593

INTERMEDIATE LEVEL

A/C	FLIGHT HOURS	MFHBMA	MA/FH X10-3	MTTR	MMH/MA	MEN/MA	MMH/FH
A-4M	35,571	11,857.0	0.1	0.67	1.33	2.0	.000
A-6E	87,564						
A-7E	159,611	877.0	1.1	4.95	5.26	1.1	.006
AV-8A	19,396	881.6	1.1	0.55	0.55	1.0	.001
F-4J	115,070	5,230.5	0.2	3.65	5.78	1.6	.001
F-8J	18,317						
F-14A	51,286	1,554.1	0.6	5.52	7.81	1.4	.005
P-3C	125,860	2,927.0	0.3	0.54	0.68	1.3	.000
S-3A	60,552	4,657.8	0.2	1.08	1.23	1.1	.000

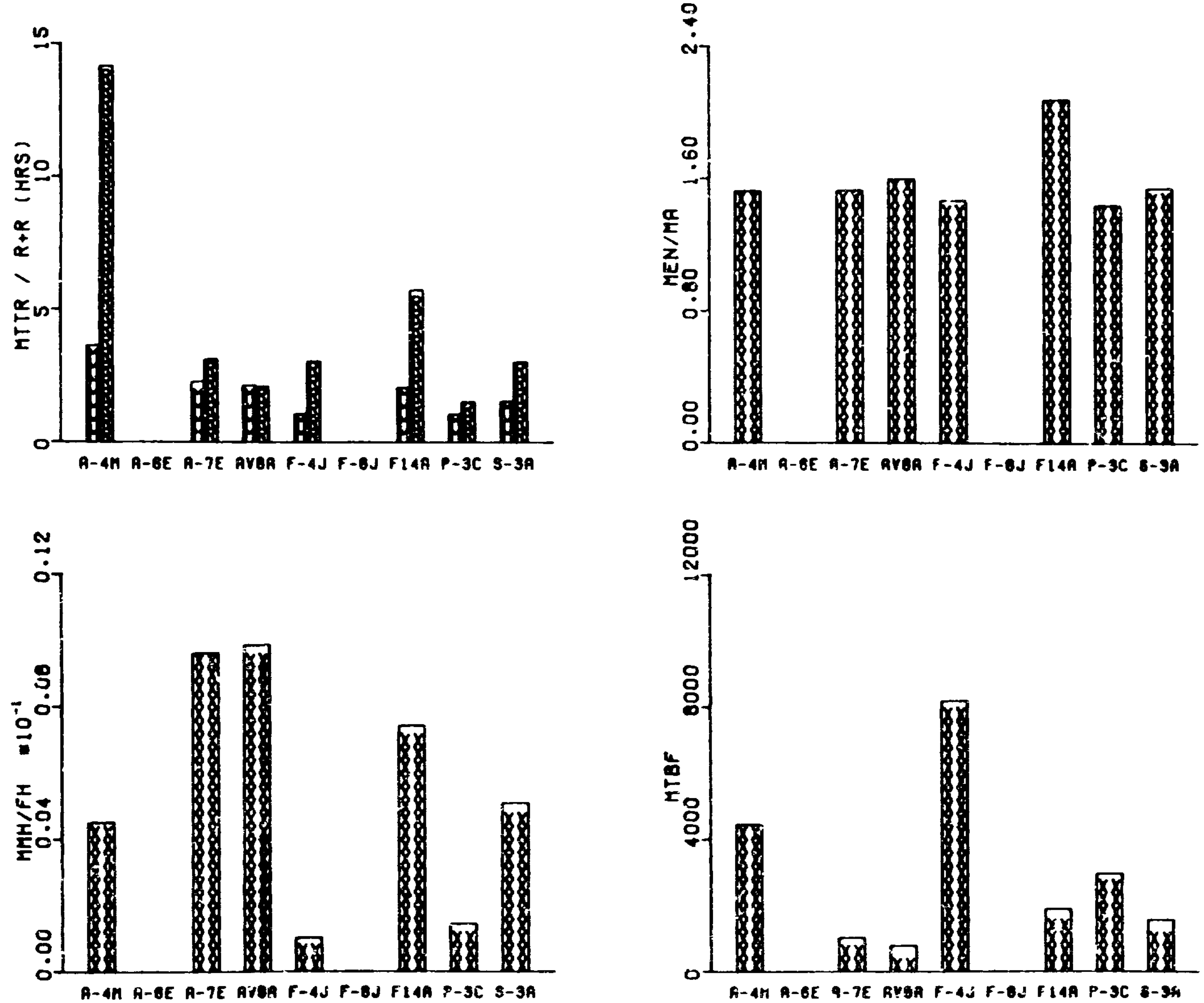


FIGURE 6.33 SELECTED GRAPHICAL DATA - CABIN TEMP CONTROL

6.9 UTILITY SYSTEMS

6.9.1 Cabin Temperature Control (See preceding Table and Figure 6.33)

WORK UNIT CODES

A-4 41126	A-6 N/A	A-7 41134	AV-8 41126	F-4 4111J
F-8 N/A	F-14 41152	P-3 41156	S-3 4113F	

DISCUSSION

Comments:

Excepting the A-4M and AV-8A, the cabin temperature controllers install in the same manner. The A-4M remove and replace data sample of two makes the R+R time presented statistically unrepresentative. The AV-8A 3-M data does not coincide with the qualitative analyses presented in the Qualitative Maintenance Experience Handbook. The AV-8A controller, console mounted similar to other aircraft, has hard-wired switches. This involves unsoldering, soldering, unpotting, and potting electrical connections in the cockpit or cutting and later splicing wires. This feature is not only undesirable, but is also very time consuming. The installation does not require an engine run, the probable reason for the low R+R time. All aircraft surveyed but the A-7E use electronic controllers, a design which is characterized by simple maintenance tasks. The A-7 design is electro-pneumatic. The P-3C uses an efficient, effective test set to perform the post-installation operational test and this produces a substantial time savings, across-the-board, over installations requiring engine runs or APU power (A-4M, A-7E, F-8J, F-14A, and S-3A).

Recommendations:

Eliminate all hard wiring of electrical components. This trait is unacceptable.

When a pneumatic design is used, pneumatic fittings should be different sizes to avoid mis-connections.

Modular units are less time consuming than component designs and, as such, are preferred.

Maximum use of BIT should be standard protocol.

TABLE 6.34 MAINTENANCE DATA - GENERATOR CONTROL/SUPERVISORY PANELS

WORK UNIT CODES

A-4	N/A	A-6	42121	A-7	42216	AV-8	N/A	F-4	42127
F-8	4222C	F-14	42124	P-3	42113	S-3	42114		

ORGANIZATIONAL LEVEL

A/C	FLIGHT HOURS	MFHBMA	MA/FH X10-3	MTTR	MMH/MA	MEN/MA	MMH/FH	R+R	O+I MTBF
A-4M	35,571								
A-6E	87,564	86.6	11.5	1.51	2.50	1.7	.029	2.20	280
A-7E	159,611	191.8	5.2	1.78	3.18	1.8	.017	2.19	410
AV-8A	19,396								
F-4J	115,070	920.6	1.1	2.91	7.12	2.4	.008	3.93	1,514
F-8J	18,317	389.7	2.6	5.39	11.02	2.0	.028	7.22	1,077
F-14A	51,286	1,554.1	0.6	1.32	2.92	2.2	.002	1.60	4,662
P-3C	125,860	285.4	3.5	1.39	2.05	1.5	.007	1.75	688
S-3A	60,552	107.0	9.3	1.62	2.57	1.6	.024	3.73	252

INTERMEDIATE LEVEL

A/C	FLIGHT HOURS	MFHBMA	MA/FH X10-3	MTTR	MMH/MA	MEN/MA	MMH/FH
A-4M	35,571						
A-6E	87,564	246.7	4.1	3.42	4.39	1.3	.018
A-7E	159,611	347.0	2.9	4.07	5.59	1.4	.016
AV-8A	19,396						
F-4J	115,070	1,475.3	0.7	4.38	5.40	1.2	.004
F-8J	18,317	964.1	1.0	9.74	11.39	1.2	.012
F-14A	51,286	25,643.0	0.0	2.50	3.00	1.2	.000
P-3C	125,860	524.4	1.9	6.02	7.55	1.3	.014
S-3A	60,552	350.0	2.9	3.61	6.14	1.7	.018

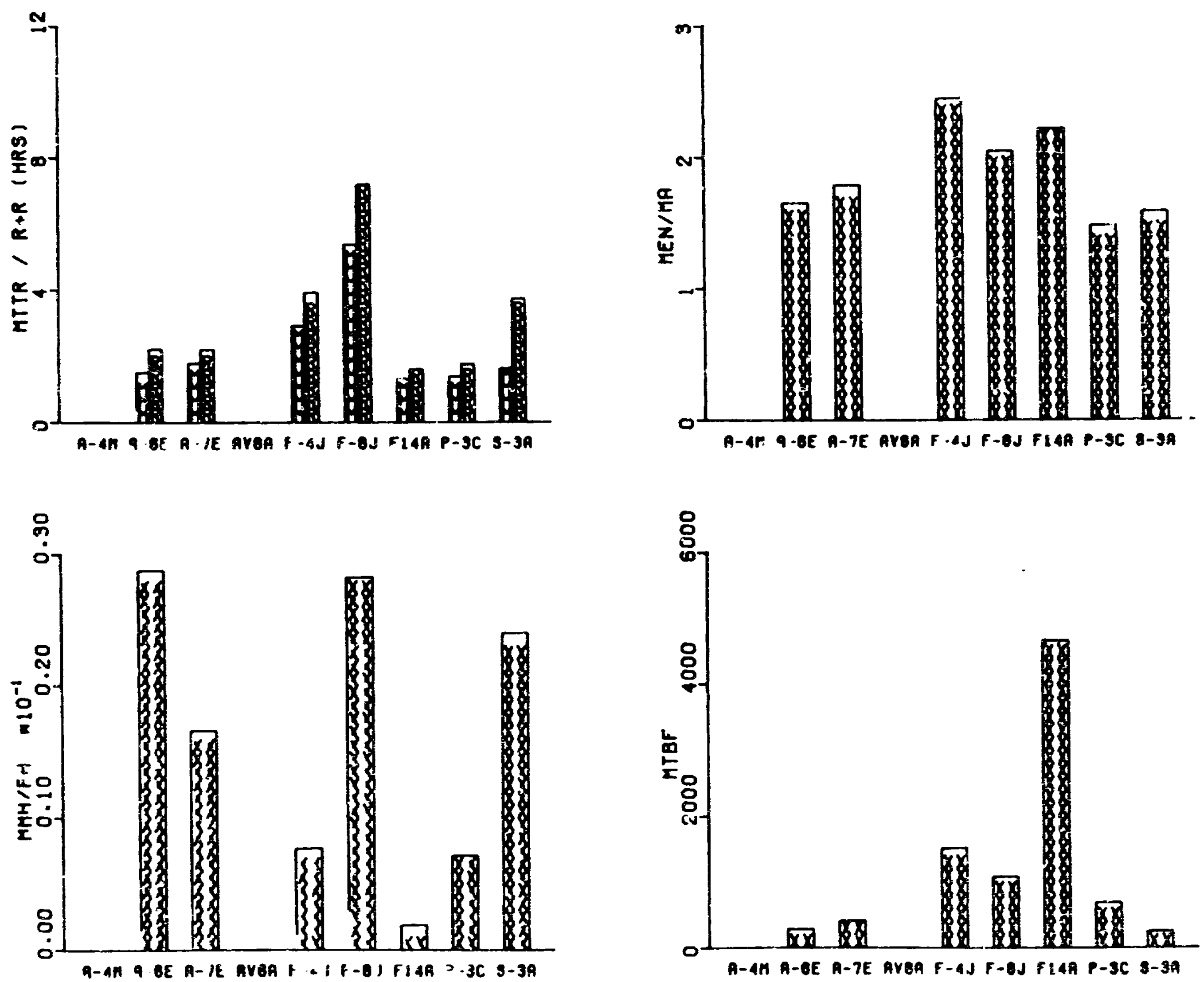


FIGURE 6.34 SELECTED GRAPHICAL DATA - GENERATOR CONTROL/SUPERVISORY PANELS

6.9.2 Generator Control/Supervisory Panels (See preceding Table and Figure 6.34)

WORK UNIT CODES

A-4 N/A	A-6 42121	A-7 42216	AV-8 N/A	F-4 42127
F-8 4222C	F-14 42124	P-3 42113	S-3 42114	

DISCUSSION

Comments:

Accessibility and mounting methods are the leading drivers of generator control/supervisory panel quantitative 3-M values. Four easily reached thumbscrews enable the F-14A to be removed and replaced quicker than any other installation studied. Likewise, the P-3C is also quick to remove but uses somewhat more time consuming Allen screws as the mounting device. On the other hand, where mounting hardware was hard to reach, slightly more than an hour longer was needed to perform the same task (S-3A, F-4J). The high maintenance parameters exhibited by the F-8J do not correlate with the qualitative data available for analysis. Qualitatively the unit is accessable and removed without undue difficulty. One possible cause for the high maintenance rates is the engine run required to operationally check the electrical system.

Recommendations:

Whenever possible, avoid the necessity of performing an engine run. Operation of engines to check non-propulsive components is time consuming, costly, and requires the aircraft be moved back and forth between special areas of the base or carrier. Designs should emphasize BIT to perform post installation checks. Avoid disassembly or removal of non-associated equipment.

Ensure mountings are visible, accessible, and utilize captive fasteners where hand room is at a premium.

TABLE 6.35 MAINTENANCE DATA - INTERNAL LIGHT CONTROL PANEL

WORK UNIT CODES

A-4	44231	A-6	44222	A-7	44231	AV-8	44121	F-4	44112
44121	F-8	N/A	F-14	44X11	P-3	N/A	S-3	N/A	

ORGANIZATIONAL LEVEL

A/C	FLIGHT HOURS	MFHBMA	MA/FH X10-3	MTTR	MMH/MA	MEN/MA	MMH/FH	R+R	O+I MTBF
A-4M	35,571	144.0	6.9	1.42	2.38	1.7	.017	1.33	282
A-6E	87,564	1,412.3	0.7	1.01	1.37	1.4	.001	1.32	2,189
A-7E	159,611	1,023.1	1.0	2.00	3.32	1.7	.003	4.44	2,574
AV-8A	19,396	775.8	1.3	1.64	2.26	1.4	.003		2,771
F-4J	115,070	114.4	8.7	1.22	1.91	1.6	.017	1.00	163
F-8J	18,317								
F-14A	51,286	246.6	4.1	2.27	5.48	2.4	.022	3.27	327
P-3C	125,860								
S-3A	60,552								

INTERMEDIATE LEVEL

A/C	FLIGHT HOURS	MFHBMA	MA/FH X10-3	MTTR	MMH/MA	MEN/MA	MMH/FH
A-4M	35,571	320.5	3.1	3.45	4.75	1.4	.015
A-6E	87,564	7,297.0	0.1	3.96	4.54	1.1	.001
A-7E	159,611	4,836.7	0.2	4.80	4.92	1.0	.001
AV-8A	19,396						
F-4J	115,070	16,438.6	0.1	2.64	3.21	1.2	.000
F-8J	18,317						
F-14A	51,286	309.0	3.2	3.58	5.89	1.6	.019
P-3C	125,860						
S-3A	60,552						

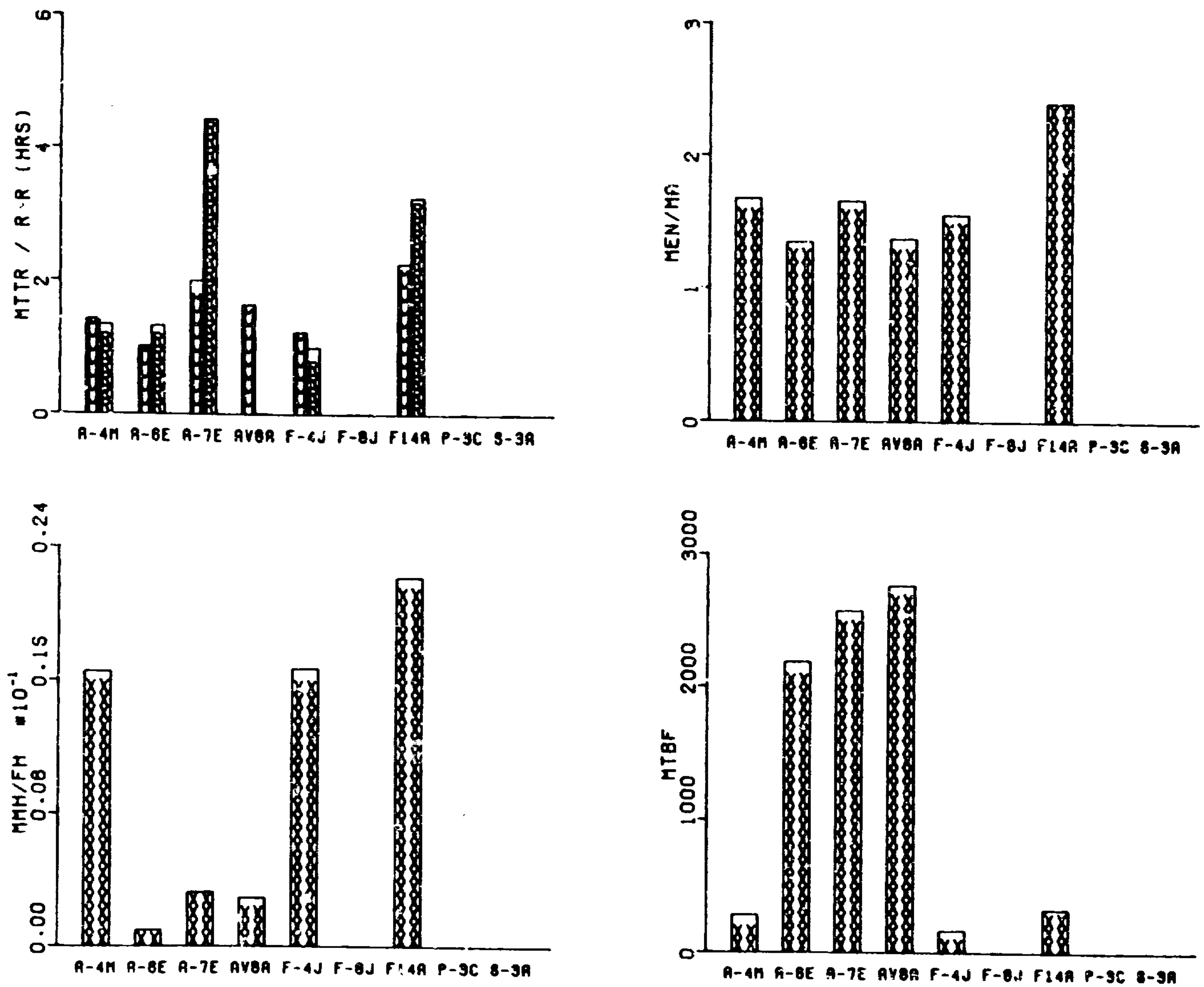


FIGURE 6.35 SELECTED GRAPHICAL DATA - INTERNAL LIGHT CONTROL PANEL

6.9.3 Internal Light Control Panel (See preceding Table and Figure 6.35)

WORK UNIT CODES

A-4 44231	A-6 44222	A-7 44231	AV-8 44121	F-4 44112, 44121
F-8 N/A	F-14 44X11	P-3 N/A	S-3 N/A	

DISCUSSION

Comments:

The requirement for an exterior fuselage panel to be removed creates extra effort and drives all of the A-7E maintenance 3-M values up considerably over the other similar installations. The F-14A component evaluated qualitatively in Reference 6 is a sub-component of the light control system and is not the pilot operated control. As such direct comparison of its quantitative maintenance values with other aircraft would serve no purpose. The AV-8A and F-4J sample size for removals is too small to use their quantitative numbers in a valid comparison to the other aircraft. All the controls evaluated, except the F-14A, are console mounted with a minimum number of attachment points.

Recommendations:

Eliminate hand wiring of controls. Hand wiring of components is an unacceptable maintenance feature even under situations of extreme weight penalties.

Cockpit console panels should not require removal of adjacent equipment or exterior access panels to perform maintenance.

TABLE 6.36 MAINTENANCE DATA - WING TIP/FORMATION LIGHTS

WORK UNIT CODES

A-4	44111	A-6	44115	A-7	N/A	AV-8	N/A	F-4	44232
F-8	N/A	F-14	44113	P-3	44127	S-3	44121		

ORGANIZATIONAL LEVEL

A/C	FLIGHT HOURS	MFHBMA	MA/FH X10-3	MTTR	MMH/MA	MEN/MA	MMH/FH	R+R	O+I MTBF
A-4M	35,571	238.7	4.2	1.07	1.74	1.6	.007	1.82	256
A-6E	87,564	145.9	6.9	1.56	2.33	1.5	.016	1.00	206
A-7E	159,611								
AV-8A	19,396								
F-4J	115,070	119.6	8.4	1.57	2.69	1.7	.022	2.99	135
F-8J	18,317								
F-14A	51,286	137.1	7.3	1.58	3.05	1.9	.022	3.66	194
P-3C	125,860	620.0	1.6	0.97	1.23	1.3	.002	0.75	673
S-3A	60,552	104.9	9.5	1.68	2.80	1.7	.027	4.02	141

INTERMEDIATE LEVEL

A/C	FLIGHT HOURS	MFHBMA	MA/FH X10-3	MTTR	MMH/MA	MEN/MA	MMH/FH
A-4M	35,571	35,571.0	0.0	0.00	0.00		
A-6E	87,564	21,891.0	0.0	2.43	2.43	1.0	.000
A-7E	159,611						
AV-8A	19,396						
F-4J	115,070	19,178.3	0.1	3.42	4.17	1.2	.000
F-8J	18,317						
F-14A	51,286	3,419.1	0.3	4.60	5.67	1.2	.002
P-3C	125,860	62,930.0	0.0	2.25	3.00	1.3	.000
S-3A	60,552	1,892.3	0.5	2.83	4.11	1.5	.002

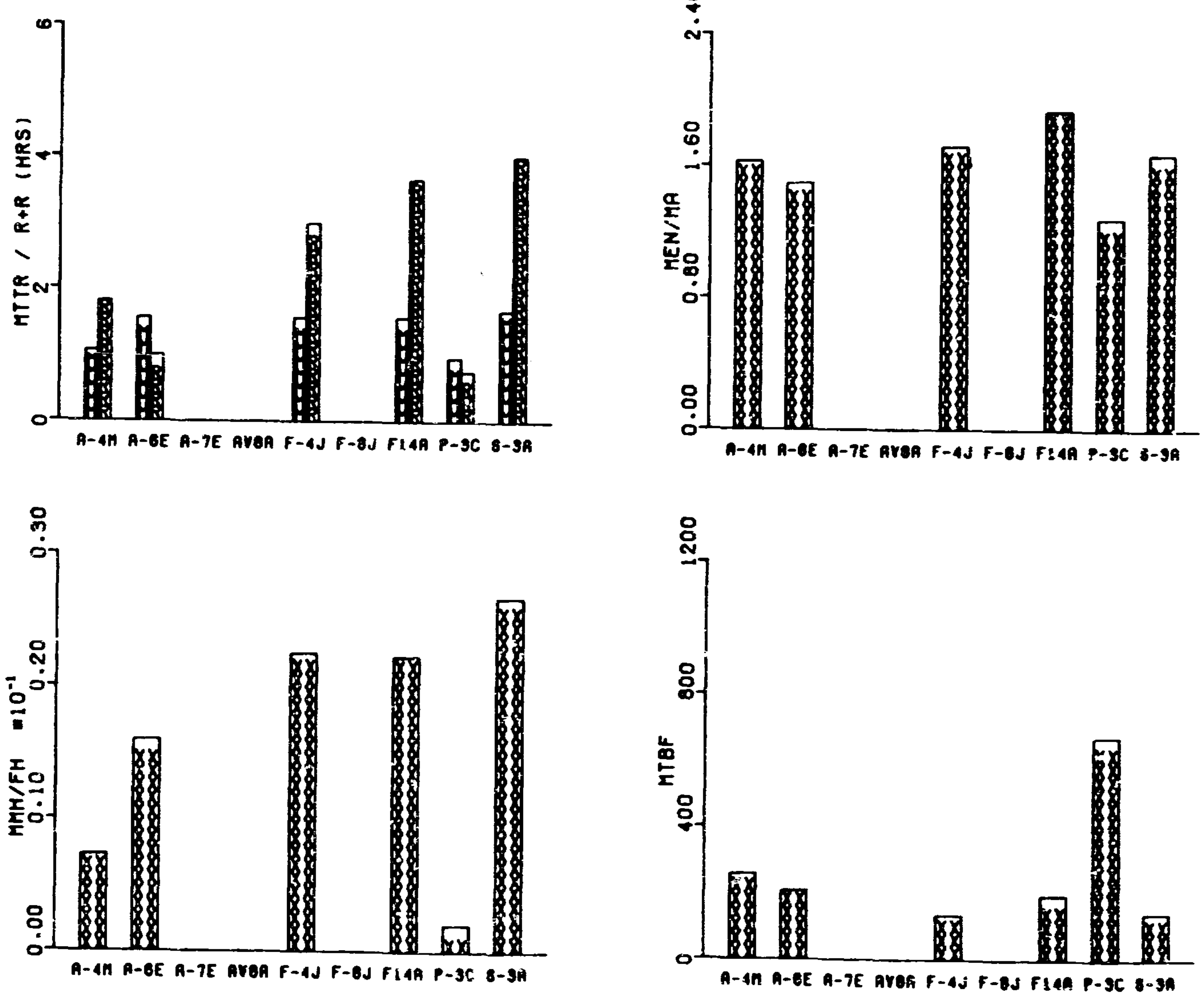


FIGURE 6.36 SELECTED GRAPHICAL DATA - WING TIP/FORMATION LIGHTS

6.9.4 Wing Tip/Formation Lights (See preceding Table and Figure 6.36)

WORK UNIT CODES

A-4 44111	A-6 44115	A-7 N/A	AV-8 N/A	F-4 44232
F-8 N/A	F-14 44113	P-3 44127	S-3 44121	

DISCUSSION

Comments:

All the lights investigated, are mounted on the wing tips. Replacement time values in the 3-M data for the A-6E and P-3C represent sample sizes (one and two respectively) too small to consider them representative. Quantitatively the F-14A data is higher than similar information presented for the other aircraft. This is due, in part, to the requirement that a ten screw fairing be removed for access. The high maintenance times experienced by the S-3A can be partially attributed to the inaccessability of the wing tips, especially the right-hand wing, when they are folded. Otherwise, qualitatively, the installation is one of the best surveyed requiring only three screws to be removed for access to the bulb.

Recommendations:

Because of the relatively low MTBF exhibited by these light assemblies, fruitful savings can be achieved by insisting designs be made as simple as possible. Government regulations determine positioning of formation lights; however, the designer should strive to design lamp assembly installations which require minimum disassembly to achieve lamp replacement. The S-3A design has achieved this.

Elimination of work stand requirements to change lamps while wings are folded would be a strong asset to shipboard operations.

Eliminate all hardwiring of lamps or lamp assemblies. Hardwiring of electrical connections is unacceptable.

TABLE 6.37 MAINTENANCE DATA - ANTI-COLLISION LIGHTS

WORK UNIT CODES

A-4	44115	A-6	N/A	A-7	N/A	AV-8	44212	F-4	44224
F-8	N/A	F-14	44140	P-3	44126	S-3	44151		

ORGANIZATIONAL LEVEL

A/C	FLIGHT HOURS	MFHBMA	MA/FH X10-3	MTTR	MMH/MA	MEN/MA	MMH/FH	R+R	O+I MTBF
A-4M	35,571	120.6	8.3	0.98	1.49	1.5	.012	1.08	144
A-6E	87,564								
A-7E	159,611								
AV-8A	19,396	62.4	16.0	1.33	2.47	1.9	.040	1.28	104
F-4J	115,070	326.9	3.1	1.37	2.15	1.6	.007	0.63	429
F-8J	18,317								
F-14A	51,286	22.4	44.6	1.57	3.17	2.0	.141	1.66	28
P-3C	125,860	129.8	7.7	1.00	1.30	1.3	.010	1.26	156
S-3A	60,552	65.3	15.3	1.31	2.06	1.6	.032	1.72	91

INTERMEDIATE LEVEL

A/C	FLIGHT HOURS	MFHBMA	MA/FH X10-3	MTTR	MMH/MA	MEN/MA	MMH/FH
A-4M	35,571	164.7	6.1	3.31	4.21	1.3	.026
A-6E	87,564						
A-7E	159,611						
AV-8A	19,396	134.7	7.4	3.75	4.74	1.3	.035
F-4J	115,070	115,070.0	0.0	1.00	2.00	2.0	.000
F-8J	18,317						
F-14A	51,286	967.7	1.0	5.95	7.68	1.3	.008
P-3C	125,860	801.7	1.2	2.62	3.29	1.3	.004
S-3A	60,552	204.6	4.9	3.43	4.25	1.2	.021

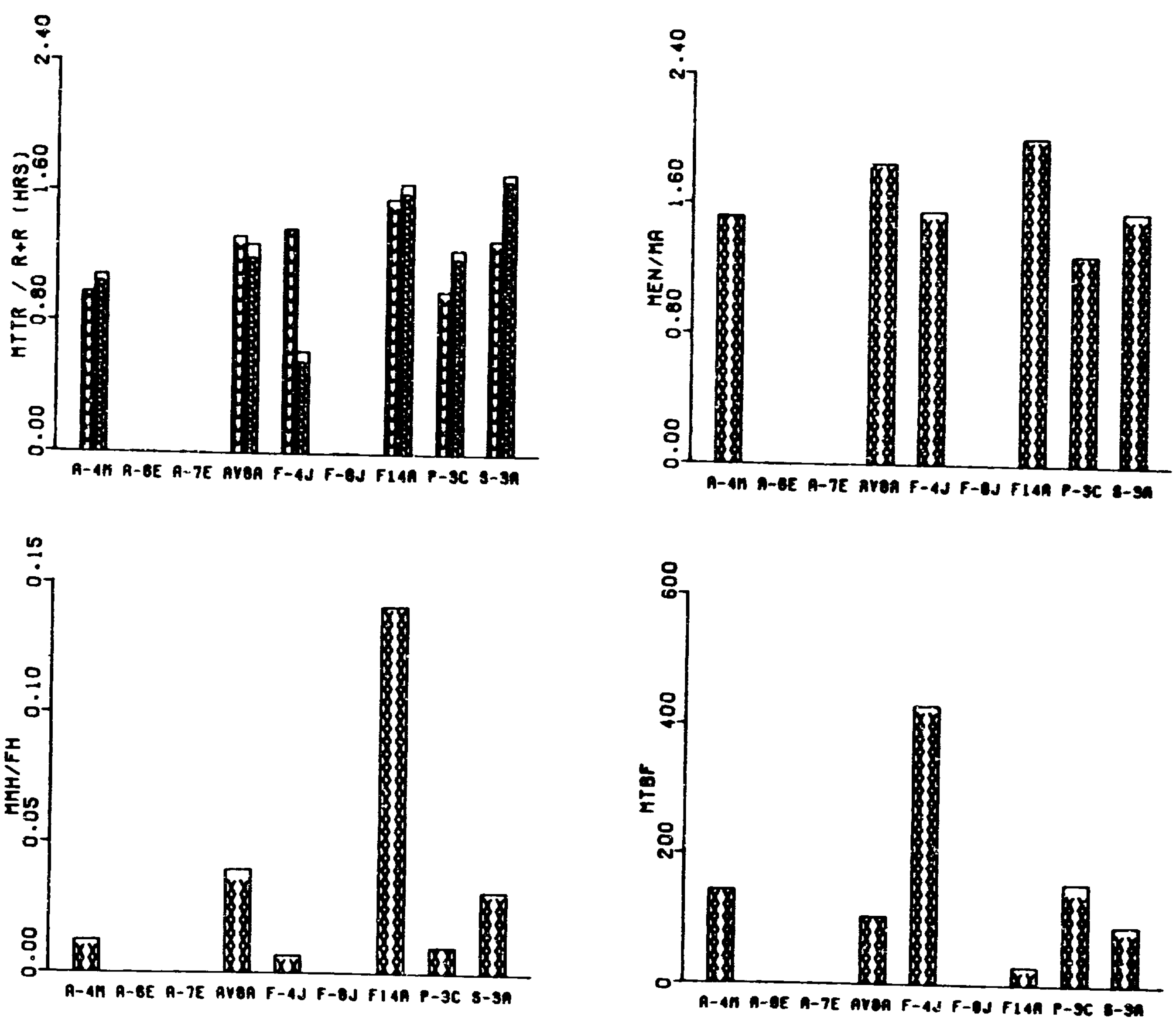


FIGURE 6.37 SELECTED GRAPHICAL DATA - ANTI-COLLISION LIGHTS

6.9.5 Anti-Collison Lights *(See preceding Table and Figure 6.37)*

WORK UNIT CODES

A-4 44115	A-6 N/A	A-7 N/A	AV-8 44212	F-4 44224
F-8 N/A	F-14 44140	P-3 44126	S-3 44151	

DISCUSSION

Comments:

Quantitatively all lamps are within a reasonable maintenance expense spectrum. Quantitatively and qualitatively the F-14A is the worst installation examined. Considering the low MTBF accredited to the F-14A anti-collision light, the requirement to remove a twelve to fourteen screw fairing (location dictates quantity) becomes rather costly maintenance-wise. The A-4M and S-3A installations are the simplest, needing a one screw removal, but differ in their quantitative values due to additional constraints created by their location. Disassembly of the lamp assembly or removal of an access panel has pushed the AV-8A and P-3C 3-M data for remove and replace actions slightly higher than the other installations. R+R time for the F-4J is based on four reported removals and is not considered a representative average.

Recommendations:

Design of anti-collision light assemblies should allow for removal of either the assembly or the lamp with a minimum number of screw removals. Designs utilizing replaceable lamps as opposed to assemblies is the preferred approach from both a maintenance and spare standpoint.

Avoid the use of special tools for lamp removal. Non-availability of a removal/insertion tool compromises this flight required component.

TABLE 6.38 MAINTENANCE DATA - TAIL POSITION LIGHTS

WORK UNIT CODES

A-4	44113	A-6	N/A	A-7	44115	AV-8	44211	F-4	44223
F-8	N/A	F-14	44111	P-3	44124	S-3	44132		

ORGANIZATIONAL LEVEL

A/C	FLIGHT HOURS	MFHBMA	MA/FH X10-3	MTTR	MMH/MA	MEN/MA	MMH/FH	R+R	O+I MTBF
A-4M	35,571	231.0	4.3	1.64	2.76	1.7	.012	1.49	294
A-6E	87,564								
A-7E	159,611	311.7	3.2	1.13	1.94	1.7	.006	2.00	340
AV-8A	19,396	167.2	6.0	0.86	1.08	1.3	.006		188
F-4J	115,070	280.7	3.6	2.03	3.50	1.7	.012		347
F-8J	18,317								
F-14A	51,286	96.4	10.4	1.92	4.02	2.1	.042	2.42	123
P-3C	125,860	487.8	2.0	1.16	1.63	1.4	.003	5.00	536
S-3A	60,552	1,187.3	0.8	1.80	2.97	1.7	.003		1,462

INTERMEDIATE LEVEL

A/C	FLIGHT HOURS	MFHBMA	MA/FH X10-3	MTTR	MMH/MA	MEN/MA	MMH/FH
A-4M	35,571	7,114.2	0.1	0.80	1.00	1.3	.000
A-6E	87,564						
A-7E	159,611	79,805.5	0.0	1.75	2.75	1.6	.000
AV-8A	19,396						
F-4J	115,070	38,356.7	0.0	3.67	4.17	1.1	.000
F-8J	18,317						
F-14A	51,286	2,442.2	0.4	1.19	1.86	1.6	.001
P-3C	125,860						
S-3A	60,552	30,276.0	0.0	1.50	3.50	2.3	.000

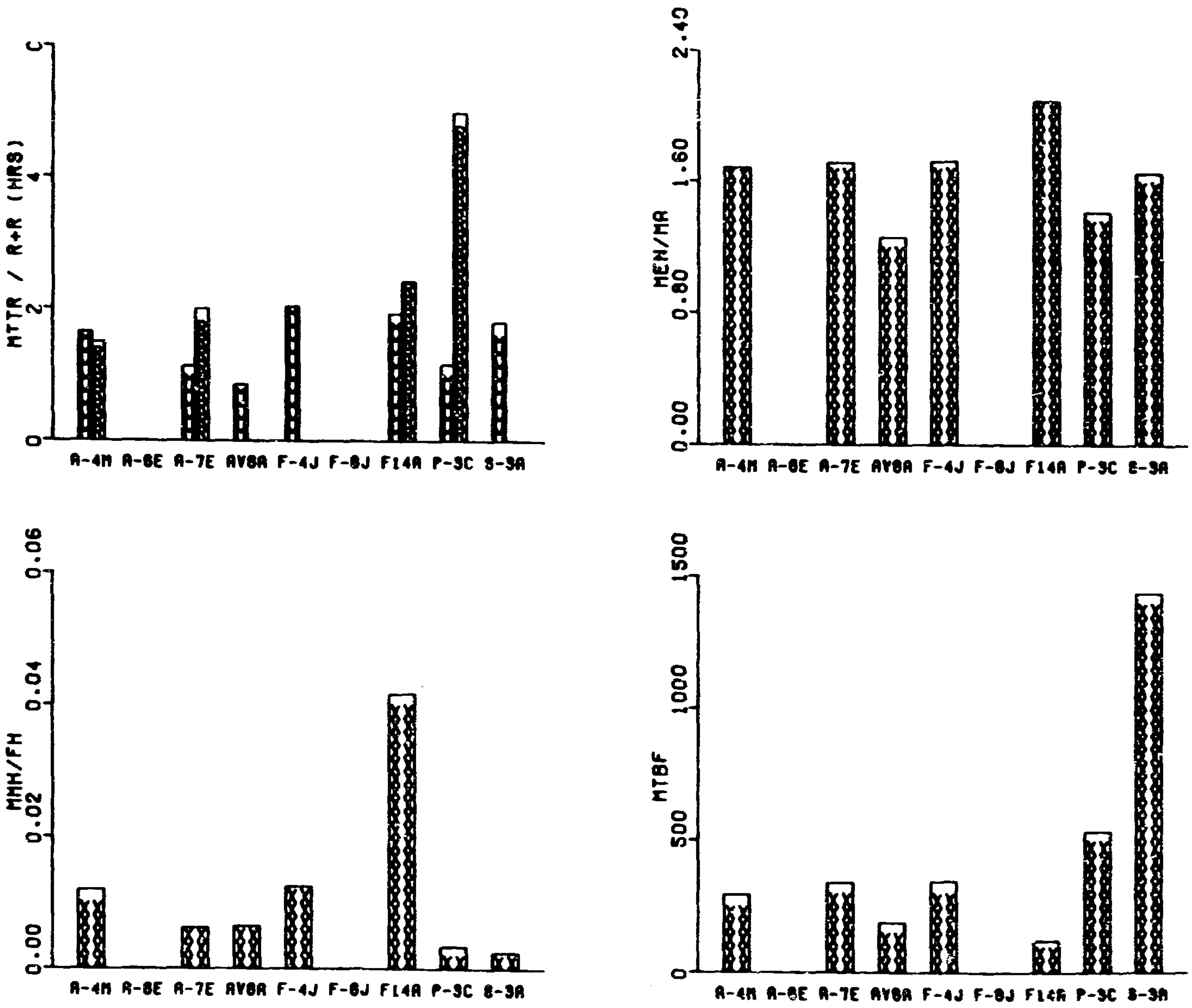


FIGURE 6.38 SELECTED GRAPHICAL DATA - TAIL POSITION LIGHTS

6.9.6 Tail Position Lights (See preceding Table and Figure 6.38)

WORK UNIT CODES

A-4 44113	A-6 N/A	A-7 44115	AV-8 44211	F-4 44223
F-8 N/A	F-14 44111	P-3 44124	S-3 44132	

DISCUSSION

Comments:

The quantitative data presented for the tail position lights is seemingly contradictory. Only two of the seven aircraft have sample sizes, for the R+R value, large enough to be considered valid. Yet, the MFHBMA for all but the S-3A infers a substantial number of maintenance actions. Since the majority of the maintenance actions can be assumed to be bulb replacements, the bulk of the data, expected to show up in the R+R time, must have been coded as "repair" instead of a remove and replace action. Hence, comparison of the remaining quantitative values points toward the F-14A as being the most burdensome. Qualitatively this is substantiated to a degree; the light assembly is held in place by twelve screws. The high MTTR of the F-4J is caused by the requirement to remove an access panel with forty screws, which is considered excessive, and from the electrical terminal location, which is about a foot away from the light assembly, creating problems running new wires through the structure.

Recommendations:

Minimize the attachment hardware whenever structurally allowable. Maintaining a simple design on this low MTBF item cannot but provide savings in maintenance to offset possible additional initial design costs.

Electrical connections should be in proximity to the assembly and hardwiring of connectors should be eliminated.

Installations allowing for bulb replacement without lamp assembly removal is preferable to removing the lamp assembly and replacing the bulb off-aircraft.

TABLE 6.39 MAINTENANCE DATA - RESERVOIR(PC OR FLT CONTROL)

WORK UNIT CODES

A-4	N/A	A-6	N/A	A-7	45213	AV-8	45112	F-4	4512A
F-8	45112	F-14	45112	P-3	45121	S-3	45214		

ORGANIZATIONAL LEVEL

A/C	FLIGHT HOURS	MFHBMA	MA/FH X10-3	MTTR	MMH/MA	MEN/MA	MMH/FH	R+R	O+I MTBF
A-4M	35,571								
A-6E	87,564								
A-7E	159,611	756.5	1.3	3.01	5.77	1.9	.008	5.94	2,046
AV-8A	19,396	2,424.5	0.4	0.98	1.73	1.8	.001		3,233
F-4J	115,070	1,162.3	0.9	4.55	9.13	2.0	.008	10.52	1,827
F-8J	18,317	495.1	2.0	2.05	3.92	1.9	.008	11.00	833
F-14A	51,286	462.0	2.2	4.52	11.08	2.5	.024	6.64	1,047
P-3C	125,860	461.0	2.2	1.58	3.55	2.3	.008	2.00	626
S-3A	60,552	508.8	2.0	2.67	5.10	1.9	.010	6.76	1,062

INTERMEDIATE LEVEL

A/C	FLIGHT HOURS	MFHBMA	MA/FH X10-3	MTTR	MMH/MA	MEN/MA	MMH/FH
A-4M	35,571						
A-6E	87,564						
A-7E	159,611	4,836.7	0.2	4.39	5.73	1.3	.001
AV-8A	19,396						
F-4J	115,070	7,191.9	0.1	6.99	6.99	1.0	.001
F-8J	18,317	6,105.7	0.2	7.17	7.80	1.1	.001
F-14A	51,286	1,192.7	0.8	9.41	15.49	1.6	.013
P-3C	125,860	41,953.3	0.0	1.33	2.00	1.5	.000
S-3A	60,552	3,784.5	0.3	4.69	6.47	1.4	.002

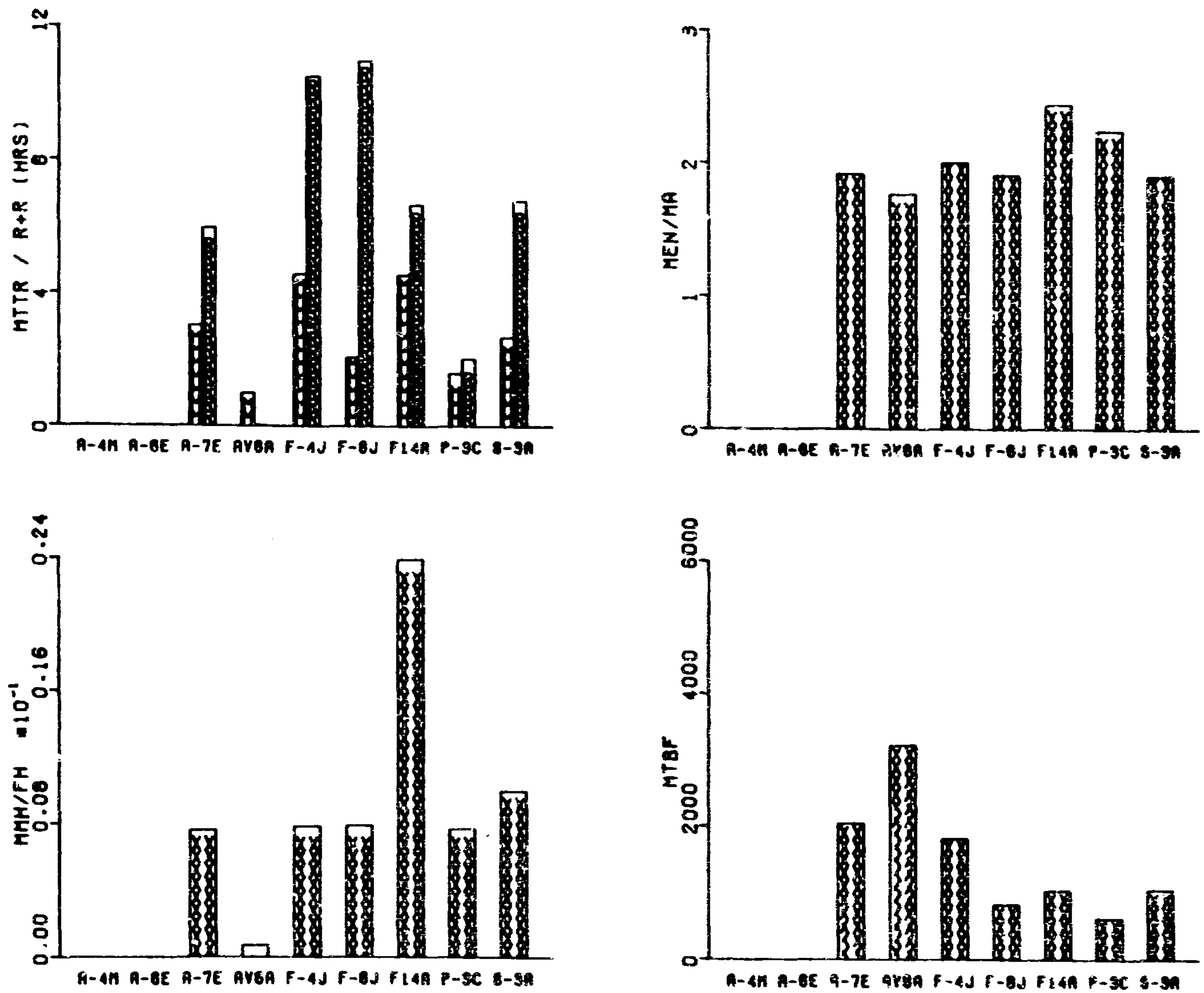


FIGURE 6.39 SELECTED GRAPHICAL DATA - RESERVOIR(PC OR FLT CONTROL)

6.9.7 Reservoir (Power Control or Flight Control) (See preceding Table and Figure 6.39)

WORK UNIT CODES

A-4 N/A	A-6 N/A	A-7 45213	AV-8 45112	F-4 4512A
F-8 45112	F-14 45112	P-3 45121	S-3 45214	

DISCUSSION

<u>Comments</u>:

The maintenance figures for the AV-8A would indicate the installation was very accessible and easy to work on. However, the reservoir is placed in a totally inaccessible place requiring wing removal for even the most minor adjustment. The eight maintenance actions accounting for the time documented were probably accomplished at some point when the wing was removed for another cause. The AV-8A, F-8J, and P-3C remove and replace times are not representative of that action due to small data sizes. The high quantitative values for the F-14A can be attributed to excessive access panel requirements and the need to remove hydraulic lines which are in the removal path of the reservoir. Improving access requirements as on the A-7E, which requires no external access to reach the wheel well located reservoir, or as on the P-3C and S-3A, which have reservoirs in compartments requiring essentially no access, or as on the F-4J installation which must have one panel removed will lower MTTR and MMH/MA. The R+R time for the F-4J does not equate with the qualitative description in Reference 6. That description indicates the F-4J installation was one of the better installations surveyed. No explanation can be offered for the disparity given the information available for this analysis.

<u>Recommendations</u>:

Eliminate the requirement to remove major non-associated items such as engines, wing, or other structural items. Requirements such as these are costly manhour consumers and also create potential for further repair from oversight or possible mishandling.

Avoid excessive panel removals. Although panel removals are inherently simple, they are also time consumers.

Hydraulic line routing through compartments should be such as to preclude line removal at any time except to repair line damage. Line removal at any other time increases work loads and future leak potential.

Complex bleeding or reservoir operational procedures become major maintenance burdens even when those tasks are straightforward.

The majority of reservoirs are held in place by steel bands with simple fasteners - a good maintenance feature.

TABLE 6.40 MAINTENANCE DATA - LIQUID OXYGEN CONVERTER

WORK UNIT CODES

A-4	47111	A-6	47111	A-7	47111	AV-8	47111	F-4	47111
F-8	47115	F-14	47111	P-3	N/A	S-3	47111		

ORGANIZATIONAL LEVEL

A/C	FLIGHT HOURS	MFHBMA	MA/FH X10-3	MTTR	MMH/MA	MEN/MA	MMH/FH	R+R	O+I MTBF
A-4M	35,571	183.4	5.5	0.96	1.66	1.7	.009	0.79	296
A-6E	87,564	94.5	10.6	1.12	1.61	1.4	.017	1.17	144
A-7E	159,611	255.8	3.9	0.97	1.14	1.2	.004	1.06	315
AV-8A	19,396	312.8	3.2	1.17	1.47	1.2	.005	1.03	373
F-4J	115,070	145.3	6.9	0.95	1.29	1.4	.009	0.92	128
F-8J	18,317	590.9	1.7	2.65	4.23	1.6	.007	10.50	833
F-14A	51,286	158.8	6.3	0.91	1.18	1.3	.007	1.02	208
P-3C	125,860								
S-3A	60,552	202.5	4.9	0.94	1.21	1.3	.006	1.02	378

INTERMEDIATE LEVEL

A/C	FLIGHT HOURS	MFHBMA	MA/FH X10-3	MTTR	MMH/MA	MEN/MA	MMH/FH
A-4M	35,571	234.0	4.3	7.56	8.72	1.2	.037
A-6E	87,564	148.2	6.7	3.13	3.83	1.2	.026
A-7E	159,611	334.6	3.0	4.65	4.92	1.1	.015
AV-8A	19,396	451.1	2.2	14.46	14.84	1.0	.033
F-4J	115,070	151.8	6.6	4.76	5.34	1.1	.035
F-8J	18,317	3,663.4	0.3	1.80	1.90	1.1	.001
F-14A	51,286	214.6	4.7	3.41	3.53	1.0	.016
P-3C	125,860						
S-3A	60,552	376.1	2.7	4.11	4.52	1.1	.012

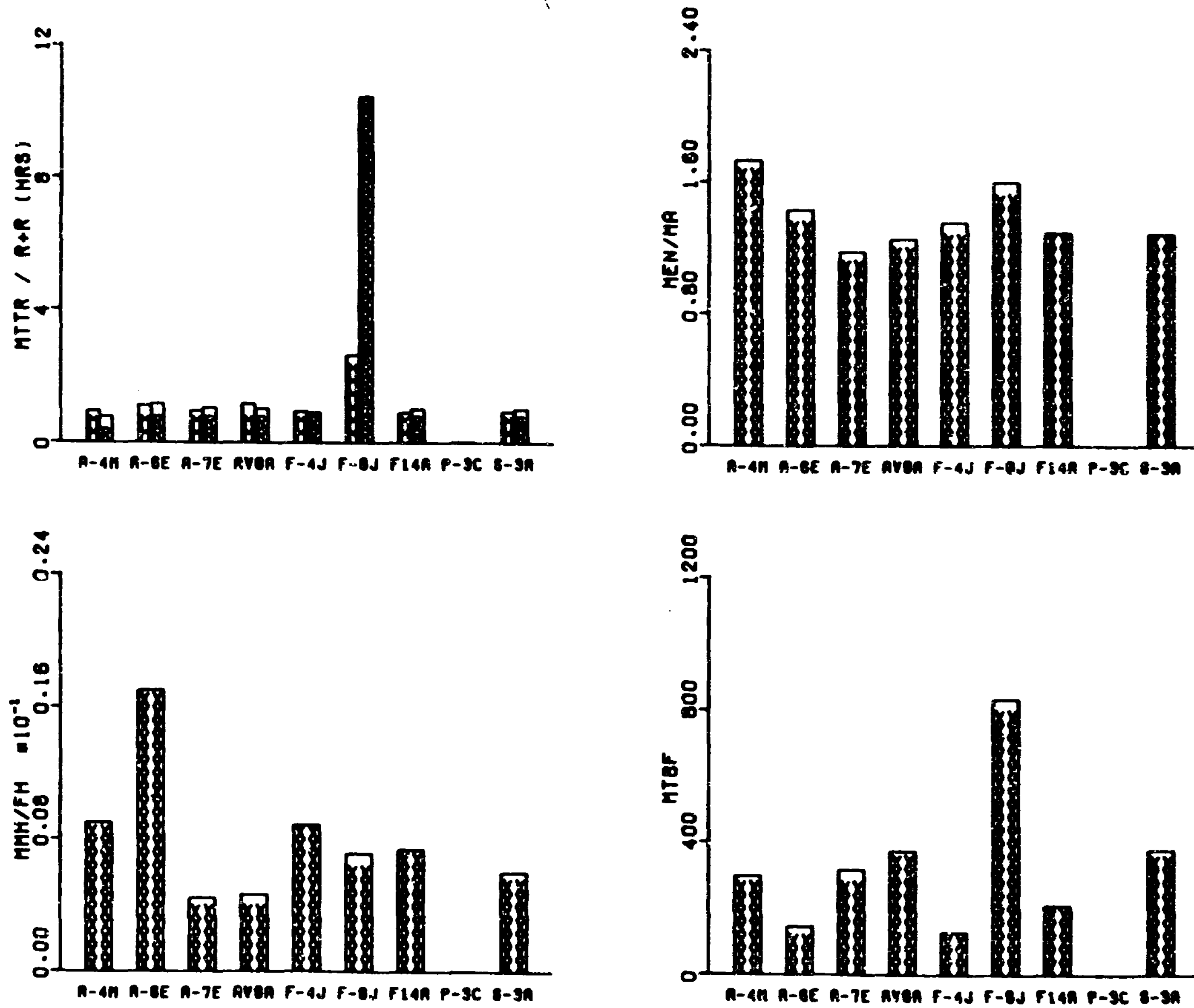


FIGURE 6.40 SELECTED GRAPHICAL DATA - LIQUID OXYGEN CONVERTER

6.3.5 Liquid Oxygen Converter (See preceding Table and Figure 6.40)

WORK UNIT CODES

A-4 47111	A-6 47111	A-7 47111	AV-8 47111	F-4 47111
F-8 47115	F-14 47111	P-3 N/A	S-3 47111	

DISCUSSION

Comments:

Very little can be said about liquid oxygen converters. Naval standards require liquid oxygen converters be a rapid order exchangeable item. This intent has been accomplished on all but the older F-8J. Essentially all the aircraft but the F-8J oxygen converters remove the same way with correspondingly little difference in quantitative 3-M data. The F-8J requires the canopy to be removed prior to the converter. The 3-M data for the F-8J reflects this poor feature.

Recommendations:

None.

TABLE 6.41 MAINTENANCE DATA - M61A1 GUN

WORK UNIT CODES

A-4	N/A	A-6	N/A	A-7	75510	AV-8	N/A	F-4	N/A
F-8	N/A	F-14	75611	P-3	N/A	S-3	N/A		

ORGANIZATIONAL LEVEL

A/C	FLIGHT HOURS	MFHBMA	MA/FH X10-3	MTTR	MMH/MA	MEN/MA	MMH/FH	R+R	O+I MTBF
A-4M	35,571								
A-6E	87,564								
A-7E	159,611	135.3	7.4	1.97	3.98	2.0	.029	2.92	301
AV-8A	19,396								
F-4J	115,070								
F-8J	18,317								
F-14A	51,286	244.2	4.1	2.47	7.64	3.1	.031	5.68	518
P-3C	125,860								
S-3A	60,552								

INTERMEDIATE LEVEL

A/C	FLIGHT HOURS	MFHBMA	MA/FH X10-3	MTTR	MMH/MA	MEN/MA	MMH/FH
A-4M	35,571						
A-6E	87,564						
A-7E	159,611	691.0	1.4	4.26	5.57	1.3	.008
AV-8A	19,396						
F-4J	115,070						
F-8J	18,317						
F-14A	51,286	1,768.5	0.6	7.90	12.79	1.6	.007
P-3C	125,860						
S-3A	60,552						

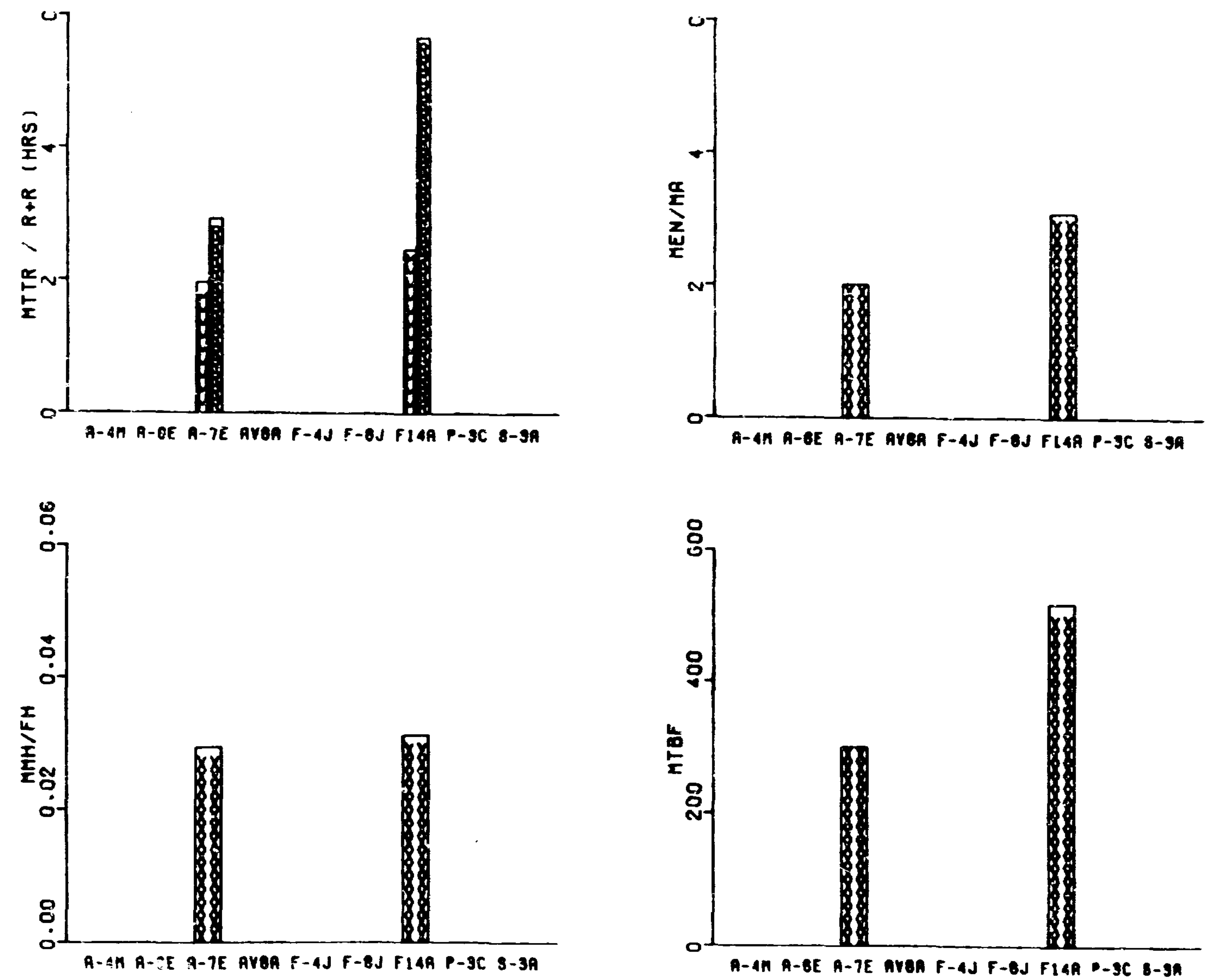


FIGURE S.41 SELECTED GRAPHICAL DATA - M61A1 GUN

6.9.9 M61A1 Gun (See preceding Table and Figure 6.41)

WORK UNIT CODES

A-4 N/A	A-6 N/A	A-7 75510	AV-8 N/A	F-4 N/A
F-8 N/A	F-14 75611	P-3 N/A	S-3 N/A	

DISCUSSION

Comments:

Comparison of the 3-M data on the M61A1 gun would indicate the A-7E installation is far superior to the F-14A. This is not so. Many small, quick fixes to associated gun components are included in the 3-M data for the A-7E gun because of the method in which the gun is Work Unit Coded and the manner in which the Work Unit Code was displayed in Reference 6. These quick fixes tend to lower all the A-7E maintenance parameters. In reality the R+R time for the A-7E gun is about 4.6 hours. The difference between this figure and the F-14A R+R time can not be qualitatively explained. Installation-wise, although both use quick release pins to hold the gun in, the A-7E requires extensive panel removal and gun disassembly to affect removal. The F-14A gun installation is considered qualitatively optimum allowing for removal of major individual components without also having to remove the entire gun assembly as in A-7E. One possible contributing reason for the higher F-14A removal time is the relatively high position of the gun location. The gun can be worked on from the ground but requires some stretching which will add to the maintenance time needed for repairs.

Recommendations:

Eliminate the need to remove entire gun assemblies to effect major component replacement. Guns should disassemble simply on the aircraft. For example, when replacing the gun mechanism, the barrels should be left in the airframe.

Avoid extensive aircraft dispaneling as this will cause maintenance costs to rise sharply.

TABLE 6.42 MAINTENANCE DATA - AMMO DRUM

WORK UNIT CODES

A-4	N/A	A-6	N/A	A-7	75531	AV-8	N/A	F-4	N/A
F-8	N/A	F-14	75631	P-3	N/A	S-3	N/A		

ORGANIZATIONAL LEVEL

A/C	FLIGHT HOURS	MFHBMA	MA/FH X10-3	MTTR	MMH/MA	MEN/MA	MMH/FH	R+R	O+I MTBF
A-4M	35,571								
A-6E	87,564								
A-7E	159,611	364.4	2.7	2.74	6.57	2.4	.018	3.12	536
AV-8A	19,396								
F-4J	115,070								
F-8J	18,317								
F-14A	51,286	827.2	1.2	5.81	15.65	2.7	.019	4.02	1,603
P-3C	125,860								
S-3A	60,552								

INTERMEDIATE LEVEL

A/C	FLIGHT HOURS	MFHBMA	MA/FH X10-3	MTTR	MMH/MA	MEN/MA	MMH/FH
A-4M	35,571						
A-6E	87,564						
A-7E	159,611	476.5	2.1	3.14	4.09	1.3	.009
AV-8A	19,396						
F-4J	115,070						
F-8J	18,317						
F-14A	51,286	1,554.1	0.6	2.96	4.62	1.6	.003
P-3C	125,860						
S-3A	60,552						

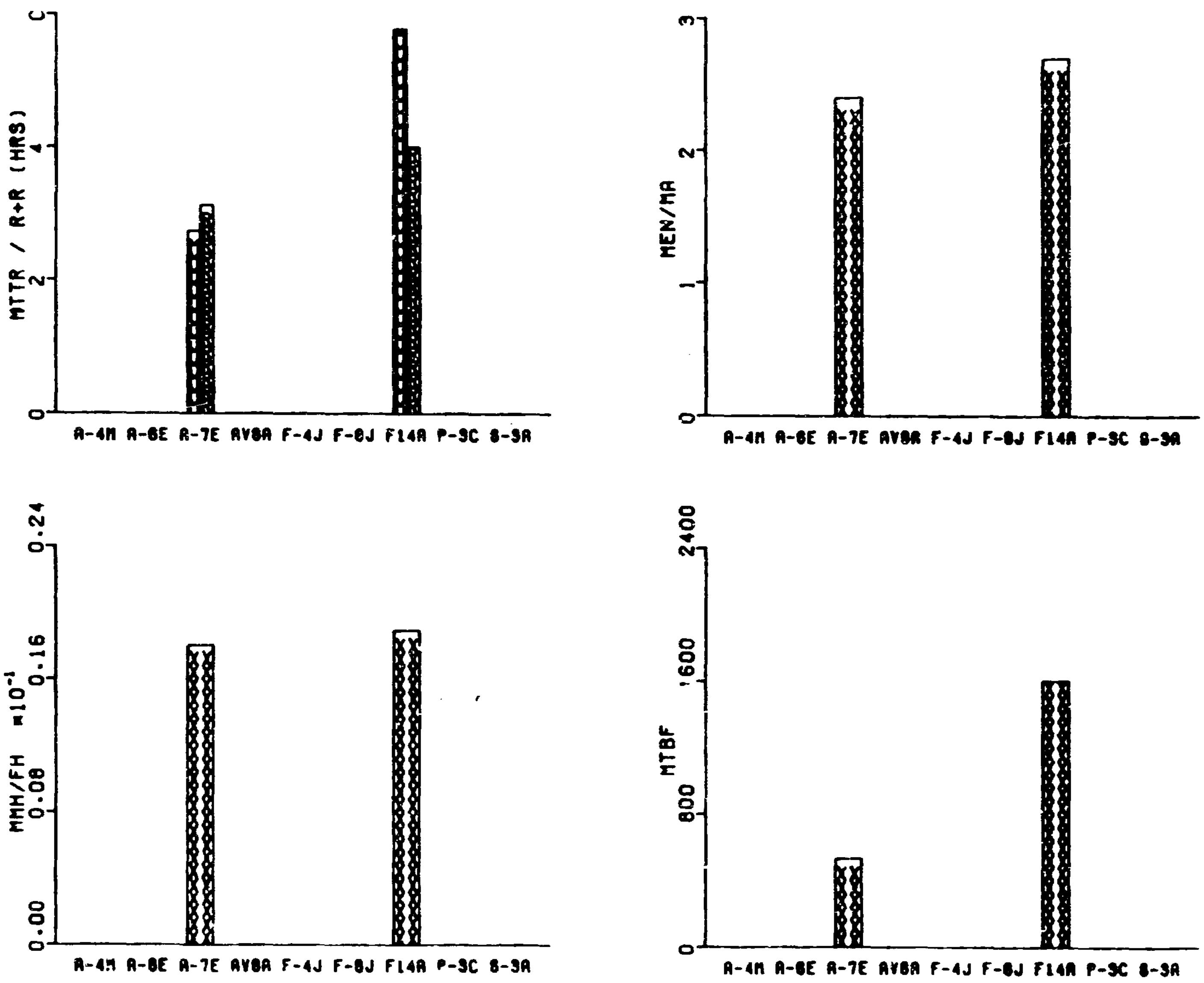


FIGURE 6.42 SELECTED GRAPHICAL DATA - AMMO DRUM

6.9.10 Ammunition (Ammo) Drum (See preceding Table and Figure 6.42)

WORK UNIT CODES

A-4 N/A	A-6 N/A	A-7 75531	AV-8 N/A	F-4 N/A
F-8 N/A	F-14 75631	P-3 N/A	S-3 N/A	

DISCUSSION

Comments:

Like the M61A1 gun, the ammunition drum on the A-7E is Work Unit Coded differently from the F-14A. This coding difference allows other ammunition drum components, which are quickly repaired, to lower the average maintenance time documented by 3-M for the drum. Analysis of the data indicates the A-7E ammunition drum removal time is actually closer to 4.8 hours. Although both drums require complex and intricate connections, the majority of the difference in removal time can be traced to ground support equipment differences. The F-14A drum lowers onto a dolly while the A-7E drum must be hoisted out of the aircraft after time consuming hoist connections have been made. Additional maintenance expenditure is necessary because ammo entrance and exit units on both aircraft are critical in timing, both are hard to work on, and adequate viewing of the installation is restricted.

Recommendations:

Minimize removal of large numbers of access panels as fastener manipulation is an acknowledged time consumer.

Facilitate installation of ammo entrance and exit units to eliminate critical timing aspects. Missed timing on current units create severe jams which subsequently add an enormous maintenance burden on ordnance technicians.

Ensure adequate room for hands and tools is provided and lines of sight to critical connections are not obscured.

When ground support equipment is employed, system connections should not be burdensome.

TABLE 6.43 MAINTENANCE DATA - AUXILIARY POWER PLANT

WORK UNIT CODES

A-4	N/A	A-6	N/A	A-7	N/A	AV-8	N/A	F-4	N/A
F-8	N/A	F-14	N/A	P-3	24210	S-3	24100		

ORGANIZATIONAL LEVEL

A/C	FLIGHT HOURS	MFHBMA	MA/FH X10-3	MTTR	MMH/MA	MEN/MA	MMH/FH	R+R	O+I MTBF
A-4M	35,571								
A-6E	87,564								
A-7E	159,611								
AV-8A	19,396								
F-4J	115,070								
F-8J	18,317								
F-14A	51,286								
P-3C	125,860							5.88	
S-3A	60,552	25.3	39.5	1.73	3.65	2.1	.144	2.91	66

INTERMEDIATE LEVEL

A/C	FLIGHT HOURS	MFHBMA	MA/FH X10-3	MTTR	MMH/MA	MEN/MA	MMH/FH	R+R	O+I MTBF
A-4M	35,571								
A-6E	87,564								
A-7E	159,611								
AV-8A	19,396								
F-4J	115,070								
F-8J	18,317								
F-14A	51,286								
P-3C	125,860								
S-3A	60,552	105.9	9.4	2.40	4.28	1.8	.040		

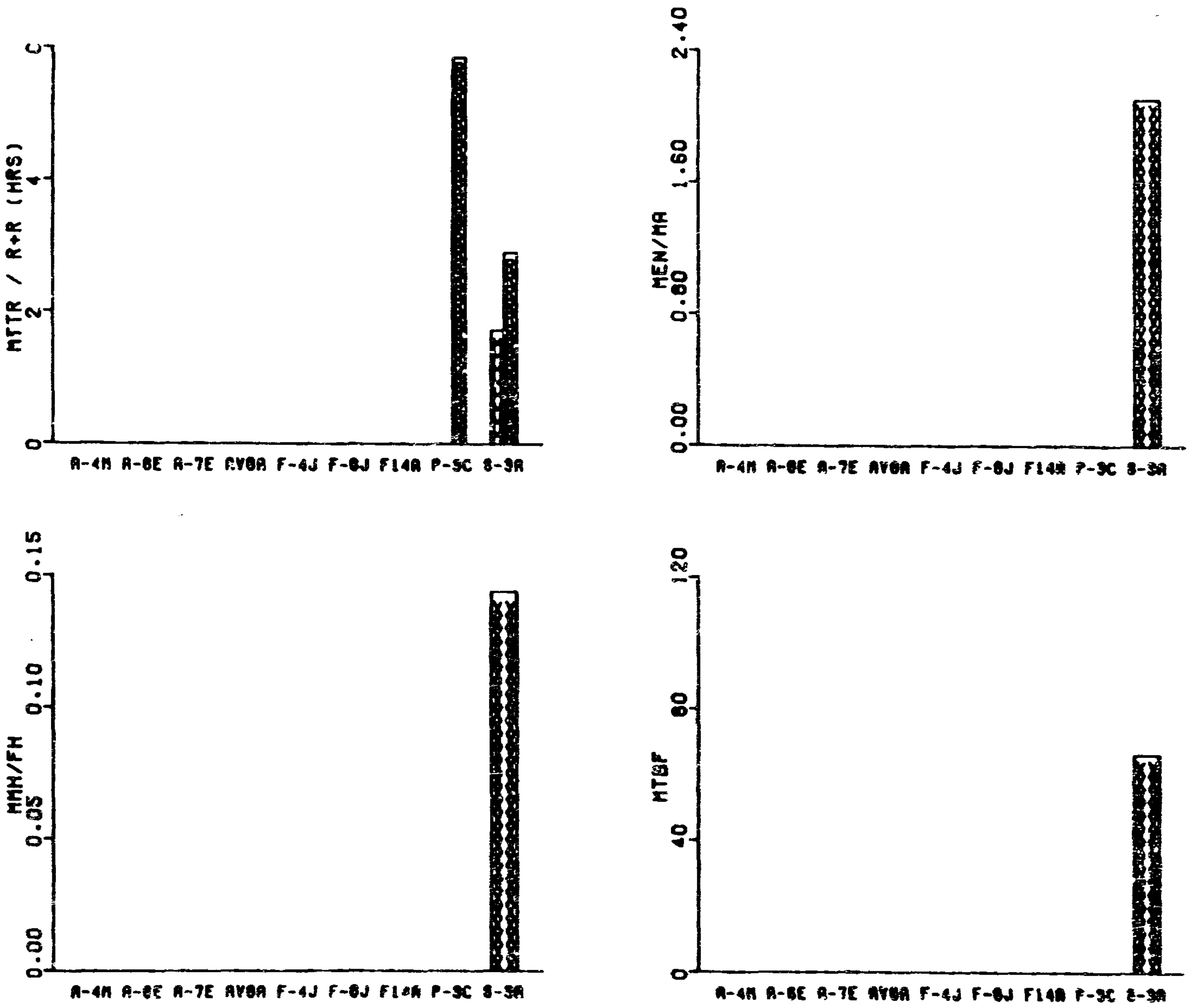


FIGURE 6.43 SELECTED GRAPHICAL DATA - AUXILIARY POWER PLANT

6.9.11 Auxiliary Power Plants (See preceding Table and Figure 6.43)

WORK UNIT CODES

A-4 N/A	A-6 N/A	A-7 N/A	AV-8 N/A	F-4 N/A
F-8 N/A	F-14 N/A	P-3 24210	S-3 24100	

DISCUSSION

Comments:

Comparison of the two auxiliary power plants qualitatively can only be made on a rudimentary basis because of their disparity. The S-3A unit is a small unit which provides electric and hydraulic power only. The P-3C unit is large and cumbersome and also provides large quantities of air. Both units fit tightly into their compartments, a trait which subsequently adds maintenance time to connections because of lack of hand room. Quantitatively, the authors cannot explain why there is no data on the P-3C power plant. Reason would dictate that in an eighteen month period some maintenance would have been performed on the power plant. The P-3C auxiliary power plant is used routinely in ground operations and preflight. Even a highly reliable item would show some maintenance considering its complexity and population. Ergo, quantitative comparisons would not be noteworthy.

Recommendations:

Ensure adequate hand room is given for connections. When sufficient hand room is not provided, connection time increases as well as the likelihood of potential leaks.

TABLE 6.44 MAINTENANCE DATA - EXHAUST GAS TEMPERATURE INDICATORS

WORK UNIT CODES

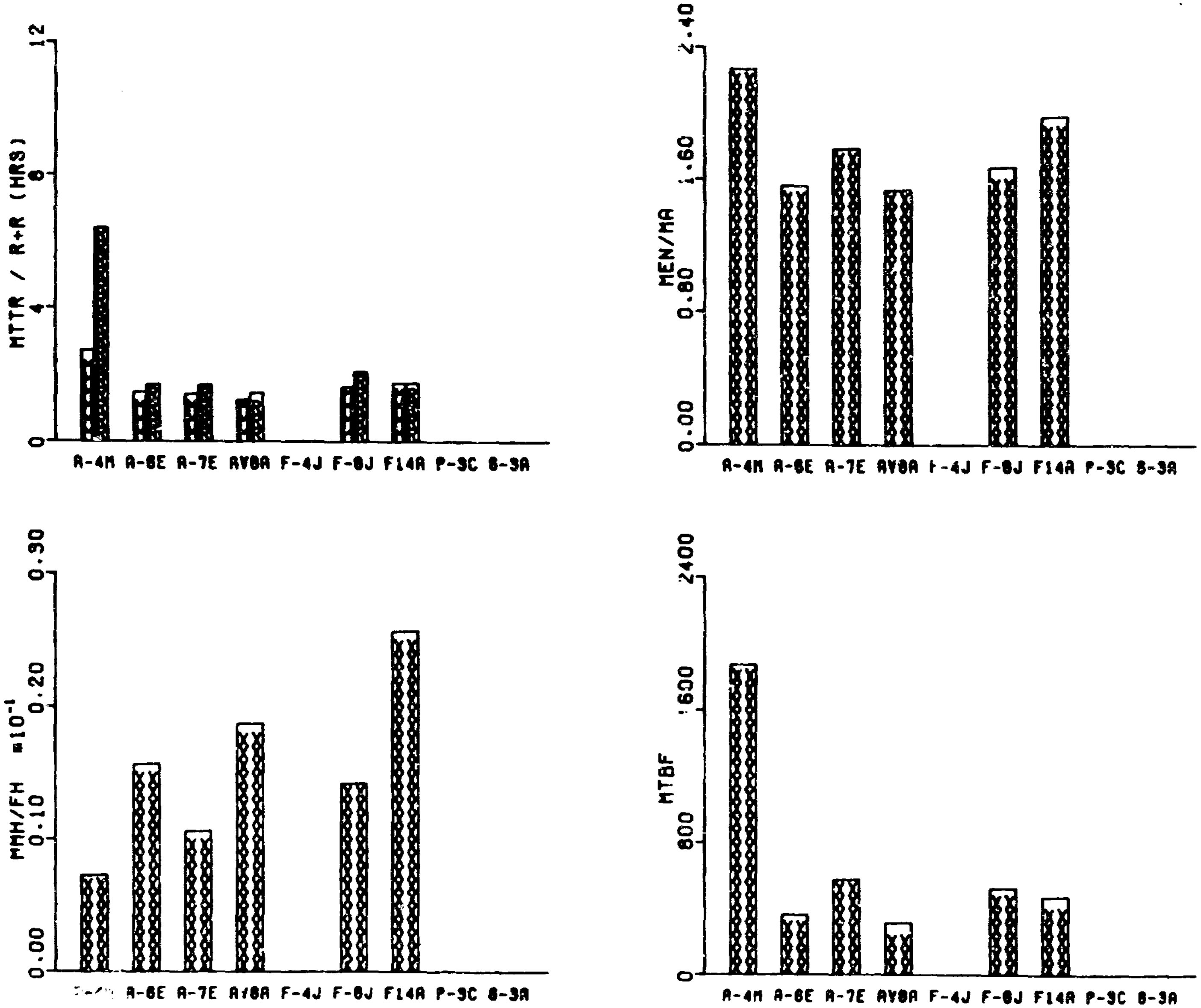
A-4	51214	A-6	51412	A-7	5111F	AV-8	51221	F-4	N/A
F-8	51541	F-14	51371	P-3	N/A	S-3	N/A		

ORGANIZATIONAL LEVEL

A/C	FLIGHT HOURS	MFHBMA	MA/FH X10-3	MTTR	MMH/MA	MEN/MA	MMH/FH	R+R	O+I MTBF
A-4M	35,571	846.9	1.2	2.73	6.18	2.3	.007	6.40	1,872
A-6E	87,564	147.4	6.8	1.48	2.30	1.6	.016	1.71	360
A-7E	159,611	239.3	4.2	1.42	2.54	1.8	.011	1.70	576
AV-8A	19,396	102.1	9.8	1.24	1.91	1.5	.019	1.45	313
F-4J	115,070								
F-8J	18,317	192.8	5.2	1.64	2.74	1.7	.014	2.09	523
F-14A	51,286	136.4	7.3	1.77	3.50	2.0	.026	1.77	471
P-3C	125,860								
S-3A	60,552								

INTERMEDIATE LEVEL

A/C	FLIGHT HOURS	MFHBMA	MA/FH X10-3	MTTR	MMH/MA	MEN/MA	MMH/FH
A-4M	35,571	2,736.2	0.4	1.12	1.43	1.3	.001
A-6E	87,564	346.1	2.9	1.73	1.76	1.0	.005
A-7E	159,611	582.5	1.7	1.70	1.76	1.0	.003
AV-8A	19,396	366.0	2.7	0.64	0.75	1.2	.002
F-4J	115,070						
F-8J	18,317	732.7	1.4	0.65	0.73	1.1	.001
F-14A	51,286	312.7	3.2	3.27	5.18	1.6	.017
P-3C	125,860						
S-3A	60,552						



F[illegible] [illegible].44 SELECTED GRAPHICAL DATA - EXHAUST GAS TEMPERATURE INDICATORS

6.10 INSTRUMENT SYSTEMS

6.10.1 Exhaust Gas Temperature Indicators (See preceding Table and Figure 6.44)

WORK UNIT CODES

A-4 51214	A-6 51412	A-7 5111F	AV-8 51221	F-4 N/A
F-8 51541	F-14 51371	P-3 N/A	S-3 N/A	

DISCUSSION

Comments:

The majority of the R+R times recorded are in accord, indicating the similarity of the installations. The exception is the time for the A-4M where the large variance, between the high A-4M time, and the low AV-8A time, is incongruous to the analysis of the installations. Both are removed by loosening one screw (which releases a clamp), removing one electrical connector, and both require an engine run following replacement. The nearly four hour difference therefore is unexplainable by the physical evidence of the installations. One ponders what impact the after installation engine run has on the recorded R+R time, or if the documentation is more inclusive for the A-4M. (Fault isolation, set-up time, engine run, etc.)

Recommendations:

Engine run after replacement should be eliminated through design of an instrument that can be set-up and checked utilizing a test set.

Require use of quick disconnects on all electrical connectors.

Require indicator face plates be part of the instrument eliminating separate removal.

Utilize clamp type installation wherever possible.

TABLE 6.45 MAINTENANCE DATA - FUEL FLOW INDICATORS

WORK UNIT CODES

A-4	51215	A-6	51413	A-7	51118	AV-8	51313	F-4	51441
F-8	N/A	F-14	51341	P-3	51331	S-3	51341		

ORGANIZATIONAL LEVEL

A/C	FLIGHT HOURS	MFHBMA	MA/FH X10-3	MTTR	MMH/MA	MEN/MA	MMH/FH	R+R	O+I MTBF
A-4M	35,571	936.1	1.1	1.43	2.94	2.0	.003	1.33	1,694
A-6E	87,564	165.5	6.0	1.31	1.87	1.4	.011	1.52	421
A-7E	159,611							2.08	
AV-8A	19,396	265.7	3.8	1.55	2.43	1.6	.009	2.36	554
F-4J	115,070	477.5	2.1	1.79	3.61	2.0	.008	1.86	1,009
F-8J	18,317								
F-14A	51,286	303.5	3.3	1.53	2.95	1.9	.010	2.10	666
P-3C	125,860	414.0	2.4	1.16	1.46	1.3	.004	1.21	695
S-3A	60,552	126.4	7.9	1.25	1.87	1.5	.015	1.69	594

INTERMEDIATE LEVEL

A/C	FLIGHT HOURS	MFHBMA	MA/FH X10-3	MTTR	MMH/MA	MEN/MA	MMH/FH
A-4M	35,571	1,976.2	0.5	1.08	1.74	1.6	.001
A-6E	87,564	387.5	2.6	1.37	1.41	1.0	.004
A-7E	159,611						
AV-8A	19,396	881.6	1.1	0.98	1.07	1.1	.001
F-4J	115,070	1,717.5	0.6	1.24	1.36	1.1	.001
F-8J	18,317						
F-14A	51,286	617.9	1.6	3.49	5.54	1.6	.009
P-3C	125,860	758.2	1.3	0.46	0.52	1.1	.001
S-3A	60,552	651.1	1.5	0.77	0.85	1.1	.001

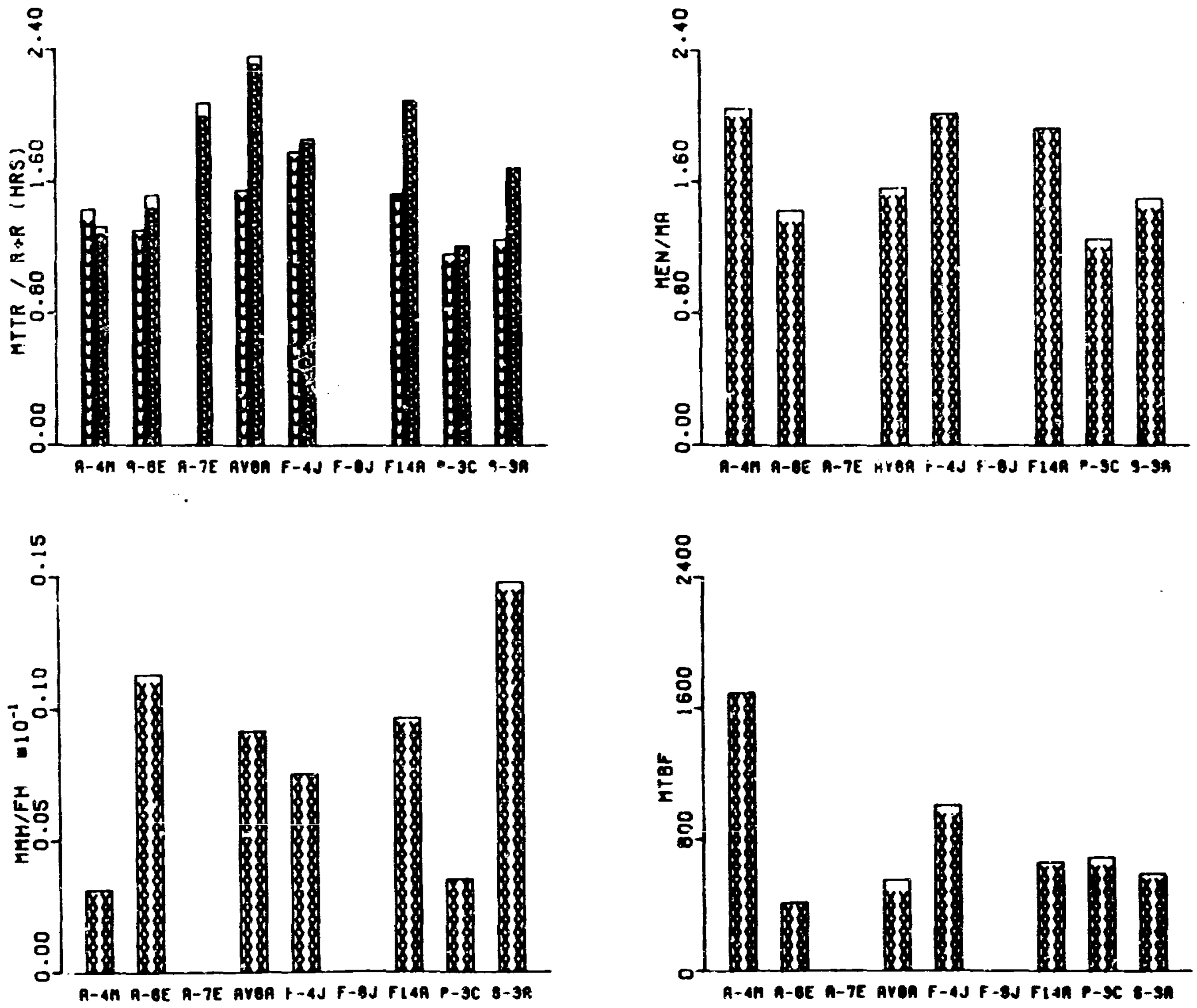


FIGURE 6.45 SELECTED GRAPHICAL DATA - FUEL FLOW INDICATORS

6.10.2 Fuel Flow Indicators (See preceding Table and Figure 6.45)

WORK UNIT CODES

A-4 51215	A-6 51413	A-7 51118	AV-8 51513	F-4 51441
F-8 N/A	F-14 51341	P-3 51331	S-3 51341	

DISCUSSION

Comments:

Most of the data presented is in consonance with the task. The primary factor impacting the R+R time is the requirement for an engine turn as part of the after installation check. The AV-8A time is somewhat higher because the Nav Display Computer Panel must be removed to gain access to the indicator. In addition, wire bundle tie wraps must be cut since the wire harness is removed with the indicator.

Recommendations:

Eliminate need to remove/disturb adjacent panels or equipment to gain access to unrelated systems WRA's. This would also eliminate the need to functionally check the system that is now disturbed to facilitate other maintenance.

Ensure that all harnesses are integral to the aircraft and not the indicator. This would eliminate the need to cut and then re-tie wire bundle tie wraps whenever the indicator is removed.

Indicator design should incorporate provisions for use of a standard test set to accomplish after installation set-up and check out. This would eliminate the need for an engine run to verify serviceability of the indicator.

TABLE 6.46 MAINTENANCE DATA - FUEL QUANTITY INDICATORS

WORK UNIT CODES

A-4	51415	A-6	51711	A-7	5111A	AV-8	51312	F-4	51844
F-8	51442	F-14	51521	P-3	51511	S-3	51512		

ORGANIZATIONAL LEVEL

A/C	FLIGHT HOURS	MFHBMA	MA/FH X10-3	MTTR	MMH/MA	MEN/MA	MMH/FH	R+R	O+I MTBF
A-4M	35,571	317.6	3.1	1.73	3.21	1.9	.010	2.05	539
A-6E	87,564	99.1	10.1	2.28	3.96	1.7	.040	3.43	278
A-7E	159,611	68.0	14.7	2.62	5.33	2.0	.078	4.33	90
AV-8A	19,396	380.3	2.6	1.85	3.01	1.6	.008	2.76	746
F-4J	115,070	167.7	6.0	5.78	12.94	2.2	.077	9.78	312
F-8J	18,317	76.6	13.0	2.31	4.04	1.8	.053	2.37	98
F-14A	51,286	119.8	8.3	1.98	4.48	2.3	.037	1.89	364
P-3C	125,860	161.6	6.2	2.40	4.60	1.9	.028	2.55	195
S-3A	60,552	354.1	2.8	1.36	2.27	1.7	.006	2.48	1,408

INTERMEDIATE LEVEL

A-4M	35,571	912.1	1.1	0.65	0.83	1.3	.001
A-6E	87,564	347.5	2.9	1.04	1.09	1.0	.003
A-7E	159,611	249.8	4.0	3.30	3.47	1.1	.014
AV-8A	19,396	668.8	1.5	1.36	1.87	1.4	.003
F-4J	115,070	846.1	1.2	1.55	2.85	1.8	.003
F-8J	18,317	457.9	2.2	0.98	1.04	1.1	.002
F-14A	51,286	316.6	3.2	3.47	4.01	1.2	.013
P-3C	125,860	467.9	2.1	0.95	1.07	1.1	.002
S-3A	60,552	1,636.5	0.6	0.57	0.65	1.1	.000

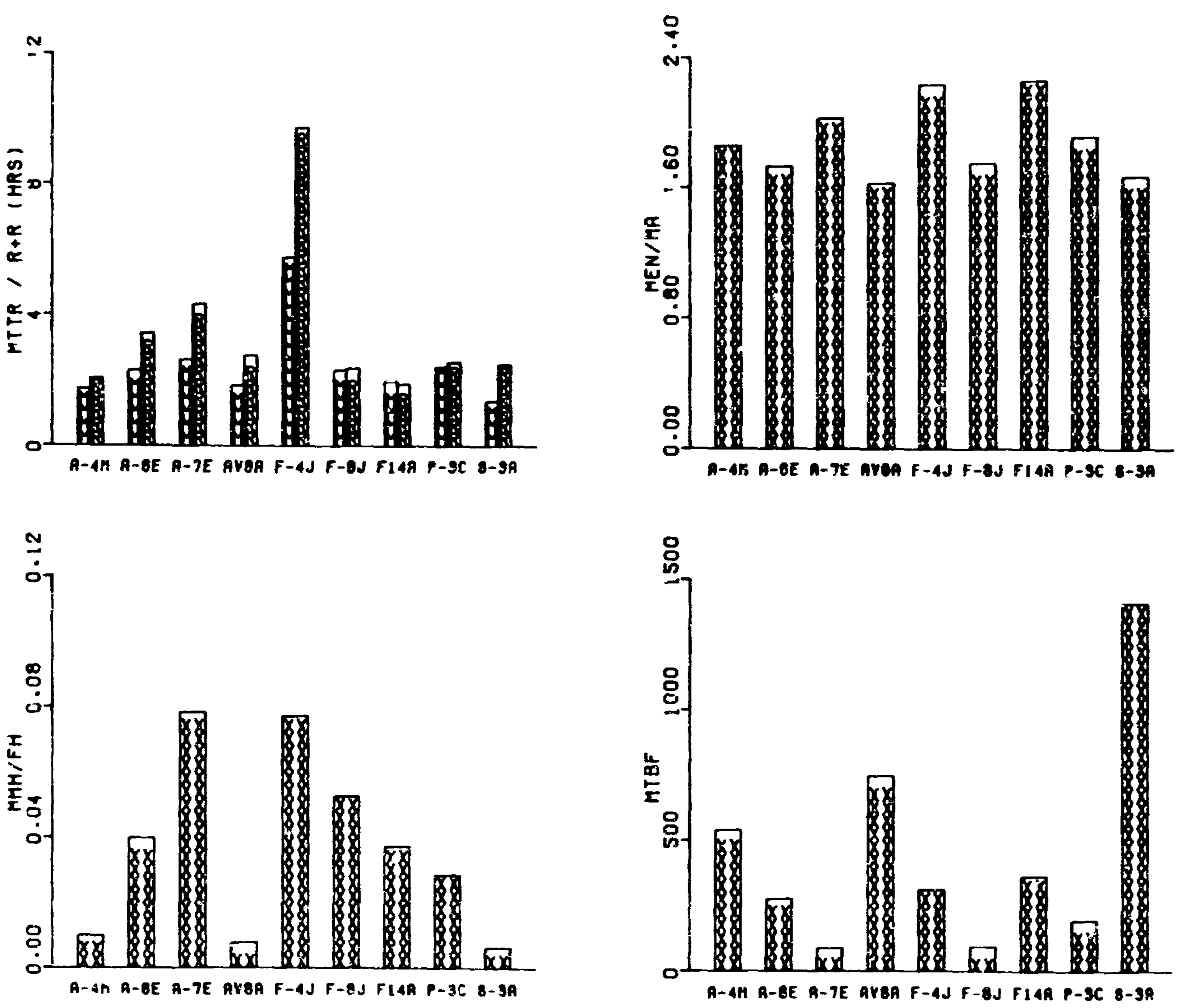


FIGURE 6.46 SELECTED GRAPHICAL DATA - FUEL QUANTITY INDICATORS

6.10.3 Fuel Quantity Indicators (See preceding Table and Figure 6.46)

WORK UNIT CODES

A-4 51415	A-6 51711	A-7 5111A	AV-8 51312	F-4 51844
F-8 51442	F-14 51521	P-3 51511	S-3 51512	

DISCUSSION

Comments:

It takes over five hours more elapsed time to remove, replace, adjust and check the fuel quantity indicator in the F-4J, than to accomplish a similar task on any other aircraft surveyed. This is attributed to the requirement to adjust and calibrate the indicator to the probes prior to securing the unit in the aircraft. (Data is based on 125 R+R actions.) The higher than average times recorded for the A-7E and A-6E are due to the fact that the electrical connector must be blind mated to the indicator, by reaching under the instrument panel on the A-7, and the frequent need to remove the Caution Panel to gain access to the indicator on the A-6. In the case of the A-7, the MTBF of 90 hours makes the installation unacceptable.

Recommendations:

Eliminate, by design, the need to remove adjacent equipment, panels, knobs or handles to gain access to unrelated systems equipment.

Ensure electrical harnesses are of sufficient length to allow physical and visual access to connectors.

Eliminate the need to calibrate indicator on the aircraft by requiring Intermediate Level calibration capability during design.

Require BIT capability in all indicator designs.

Eliminate the need for an engine run to functionally check the indicator after installation (AV-8A).

Make all harnesses integral to the aircraft and not the instrument (AV-8A).

Use a clamp type installation whenever possible.

TABLE 6.47 MAINTENANCE DATA - AIRSPEED/MACH INDICATORS

WORK UNIT CODES

A-4	51116	A-6	51111	A-7	51153	AV-8	51112	F-4	51113
F-8	51131	F-14	51131	P-3	51115	S-3	51112		

ORGANIZATIONAL LEVEL

A/C	FLIGHT HOURS	MFHBMA	MA/FH X10-3	MTTR	MMH/MA	MEN/MA	MMH/FH	R+R	O+I MTBF
A-4M	35,571	338.8	3.0	2.09	4.01	1.9	.012	3.01	671
A-6E	87,564	228.0	4.4	2.44	4.43	1.8	.019	4.12	761
A-7E	159,611	254.6	3.9	1.56	2.66	1.7	.010	1.90	536
AV-8A	19,396	668.8	1.5	1.52	2.05	1.3	.003	2.38	1,078
F-4J	115,070	108.7	9.2	1.56	2.78	1.8	.026	2.31	276
F-8J	18,317	131.8	7.6	2.64	5.21	2.0	.039	3.35	262
F-14A	51,286	391.5	2.6	1.62	3.44	2.1	.009	2.19	1,251
P-3C	125,860	364.8	2.7	2.10	3.65	1.7	.010	2.91	812
S-3A	60,552	131.1	7.6	1.93	3.27	1.7	.025	2.54	484

INTERMEDIATE LEVEL

A/C	FLIGHT HOURS	MFHBMA	MA/FH X10-3	MTTR	MMH/MA	MEN/MA	MMH/FH
A-4M	35,571	846.9	1.2	1.44	2.24	1.6	.003
A-6E	87,564	951.8	1.1	1.62	1.73	1.1	.002
A-7E	159,611	613.9	1.6	0.82	0.86	1.1	.001
AV-8A	19,396	1,616.3	0.6	1.61	3.94	2.5	.002
F-4J	115,070	363.0	2.8	1.28	1.60	1.3	.004
F-8J	18,317	426.0	2.3	1.37	1.70	1.2	.004
F-14A	51,286	1,068.5	0.9	2.57	3.47	1.3	.003
P-3C	125,860	1,023.3	1.0	0.59	0.68	1.2	.001
S-3A	60,552	571.2	1.8	0.84	1.04	1.2	.002

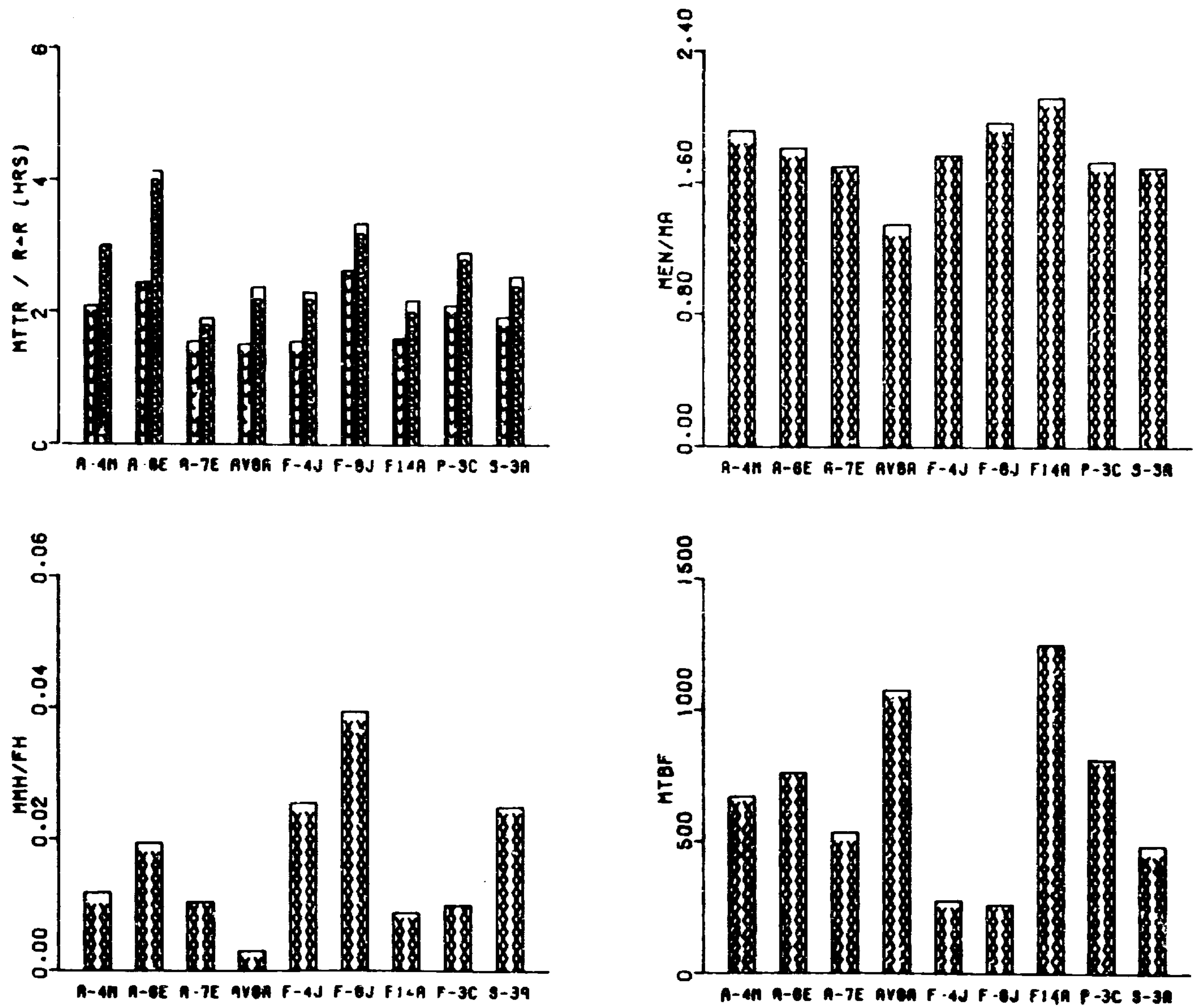


FIGURE 6.47 SELECTED GRAPHICAL DATA - AIRSPEED/MACH INDICATORS

6.10.4 Airspeed/Mach Indicators (See preceding Table and Figure 6.47)

WORK UNIT CODES

A-4 51116	A-6 51111	A-7 51153	AV-8 51112	F-4 51113
F-8 51131	F-14 51131	P-3 51115	S-3 51112	

DISCUSSION

<u>Comments</u>:

The highest R+R times recorded were experienced by those installations that require the removal of adjacent equipment or hardware and where access is considered poor. On the A-6E the glare shield must be removed and electrical disconnects made by reaching behind the instrument panel; the F-8J installation requires removal of the ADI and even after that action, access to the Airspeed Indicator connections is still poor; and, on the A-4M, a good installation is inhibited by the fact that on many of the aircraft, the pneumatic lines are short and require removal of an adjacent component to gain access to the connection. In fact, access to pneumatic connections on indicators varies considerably from installation to installation, aircraft to aircraft, and may be considered a basic problem common to most aircraft. By contrast, the relatively good R+R time reflected for the A-7E installation can be attributed to the use of a rack and panel connector which eliminates connector access problems and negates the need to remove adjacent equipment or hardware.

<u>Recommendations</u>:

Ensure length and routing of pneumatic lines and cables allow sufficient slack to permit unit to be removed an adequate distance from the instrument panel to provide hand and finger access for disconnect.

Use rack and panel type connectors wherever possible, even if use dictates design of an adapter to convert the wide variety of indicators now available to a rack and panel type mounting.

Eliminate need to remove adjacent equipment or hardware to gain access to other unrelated systems/equipment. This would also eliminate the requirement to functionally check the system that is now disturbed to facilitate maintenance.

TABLE 6.48 MAINTENANCE DATA - COUNTER DRUM ALTIMETERS

WORK UNIT CODES

A-4	51117	A-6	51118	A-7	51152	AV-8	51116	F-4	51111
F-8	51133	F-14	51111	P-3	51117	S-3	51113		

ORGANIZATIONAL LEVEL

A/C	FLIGHT HOURS	MFHBMA	MA/FH X10-3	MTTR	MMH/MA	MEN/MA	MMH/FH	R+R	O+I MTBF
A-4M	35,571	195.4	5.1	1.72	3.14	1.8	.016	2.92	387
A-6E	87,564	323.1	3.1	1.35	2.22	1.6	.007	2.23	461
A-7E	159,611	90.5	11.1	1.36	2.26	1.7	.025	1.91	193
AV-8A	19,396	200.0	5.0	1.01	1.45	1.4	.007	2.33	259
F-4J	115,070	59.2	16.9	1.41	2.43	1.7	.041	1.86	90
F-8J	18,317	45.6	21.9	1.91	3.26	1.7	.072	3.04	78
F-14A	51,286	104.9	9.5	1.41	2.60	1.8	.025	2.04	190
P-3C	125,860	265.0	3.8	1.64	2.79	1.7	.011	2.09	557
S-3A	60,552	114.7	8.7	1.82	3.10	1.7	.027	2.74	276

INTERMEDIATE LEVEL

A-4M	35,571	711.4	1.4	1.40	1.84	1.3	.003
A-6E	87,564	1,683.9	0.6	0.96	1.13	1.2	.001
A-7E	159,611	357.9	2.8	1.54	1.74	1.1	.005
AV-8A	19,396	1,140.9	0.9	0.81	0.96	1.2	.001
F-4J	115,070	279.3	3.6	1.56	2.17	1.4	.008
F-8J	18,317	199.1	5.0	1.45	1.75	1.2	.009
F-14A	51,286	296.5	3.4	1.58	1.92	1.2	.006
P-3C	125,860	817.3	1.2	1.27	1.49	1.2	.002
S-3A	60,552	406.4	2.5	1.14	1.33	1.2	.003

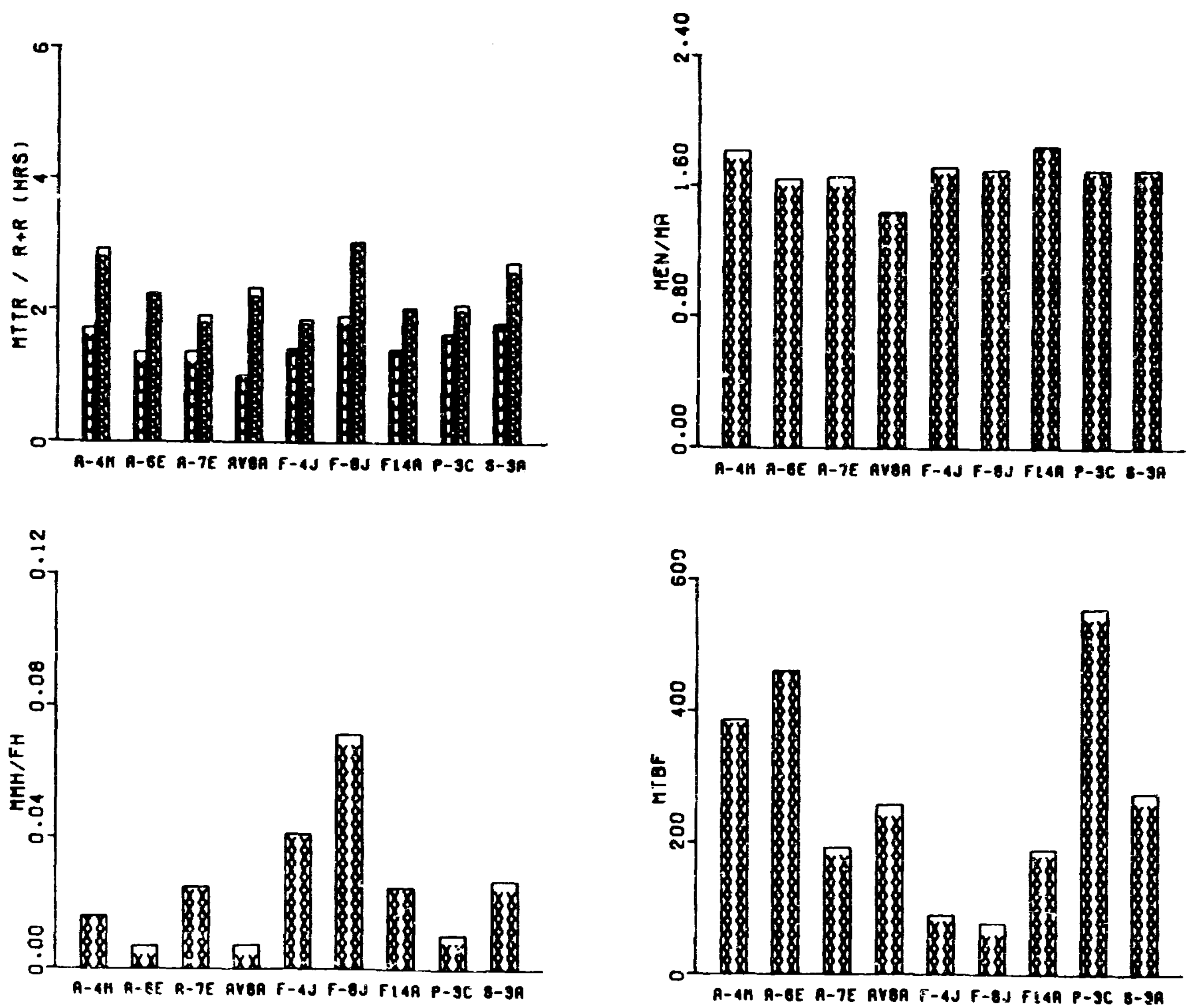


FIGURE 6.48 SELECTED GRAPHICAL DATA - COUNTER DRUM ALTIMETERS

6.10.5 Counter Drum Altimeters (See preceding Table and Figure 6.48)

WORK UNIT CODES

A-4 51117	A-6 51118	A-7 51152	AV-8 51116	F-4 51111
F-8 51133	F-14 51111	P-3 51117	S-3 51113	

DISCUSSION

Comments:

This should be a simple maintenance task. Yet, in nearly all instances, either by design or previous repair action, adjacent equipment or hardware had to be removed to gain access to the connector and pneumatic lines before the remove and replace action could be accomplished. This adds to the inclusive R+R time reflected here, although the checkout of the disturbed system could be recorded on another VIDS/MAF. When the additional documentation and removal of adjacent equipment is taken into consideration, the spread between the high and low R+R times recorded here is not considered excessive or significant.

Recommendations:

Ensure length and routing of pneumatic lines and cables allow sufficient slack to permit unit to be removed an adequate distance from the instrument panel to provide hand and finger access for disconnect.

Use rack and panel type connectors wherever possible, even if use dictates design of an adapter to convert the wide variety of indicators now available to a rack and panel type mounting.

Eliminate need to remove adjacent equipment or hardware to gain access to other unrelated systems/equipment. This would also eliminate the requirement to functionally check the system that is now disturbed to facilitate maintenance.

TABLE 6.49 MAINTENANCE DATA - ANGLE OF ATTACK INDICATORS

WORK UNIT CODES

A-4	56861	A-6	51142	A-7	51141	AV-8	51151	F-4	56861
F-8	51191	F-14	56X1C	P-3	51131	S-3	51121		

ORGANIZATIONAL LEVEL

A/C	FLIGHT HOURS	MFHBMA	MA/FH X10-3	MTTR	MMH/MA	MEN/MA	MMH/FH	R+R	O+I MTBF
A-4M	35,571	1,046.2	1.0	1.06	1.59	1.5	.002	1.05	1,976
A-6E	87,564	84.8	11.8	1.32	2.08	1.6	.025	1.69	192
A-7E	159,611	62.6	16.0	1.30	2.12	1.6	.034	1.62	114
AV-8A	19,396	1,492.0	0.7	1.25	1.66	1.3	.001	2.20	3,879
F-4J	115,070	82.4	12.1	1.45	2.60	1.8	.032	1.68	173
F-8J	18,317	52.6	19.0	1.59	2.60	1.6	.049	1.86	87
F-14A	51,286	123.0	8.1	1.24	2.41	1.9	.020	1.96	325
P-3C	125,860	198.5	5.0	1.41	2.02	1.4	.010	1.71	307
S-3A	60,552	116.9	8.6	1.46	2.31	1.6	.020	1.90	304

INTERMEDIATE LEVEL

A/C	FLIGHT HOURS	MFHBMA	MA/FH X10-3	MTTR	MMH/MA	MEN/MA	MMH/FH
A-4M	35,571	4,446.4	0.2	1.44	2.44	1.7	.001
A-6E	87,564	222.2	4.5	2.87	3.50	1.2	.016
A-7E	159,611	135.3	7.4	4.25	4.84	1.1	.036
AV-8A	19,396	9,698.0	0.1	6.25	6.25	1.0	.001
F-4J	115,070	174.6	5.7	2.82	3.55	1.3	.020
F-8J	18,317	88.1	11.4	3.15	3.78	1.2	.043
F-14A	51,286	264.4	3.8	5.14	5.84	1.1	.022
P-3C	125,860	344.8	2.9	3.61	4.20	1.2	.012
S-3A	60,552	398.4	2.5	1.75	2.09	1.2	.005

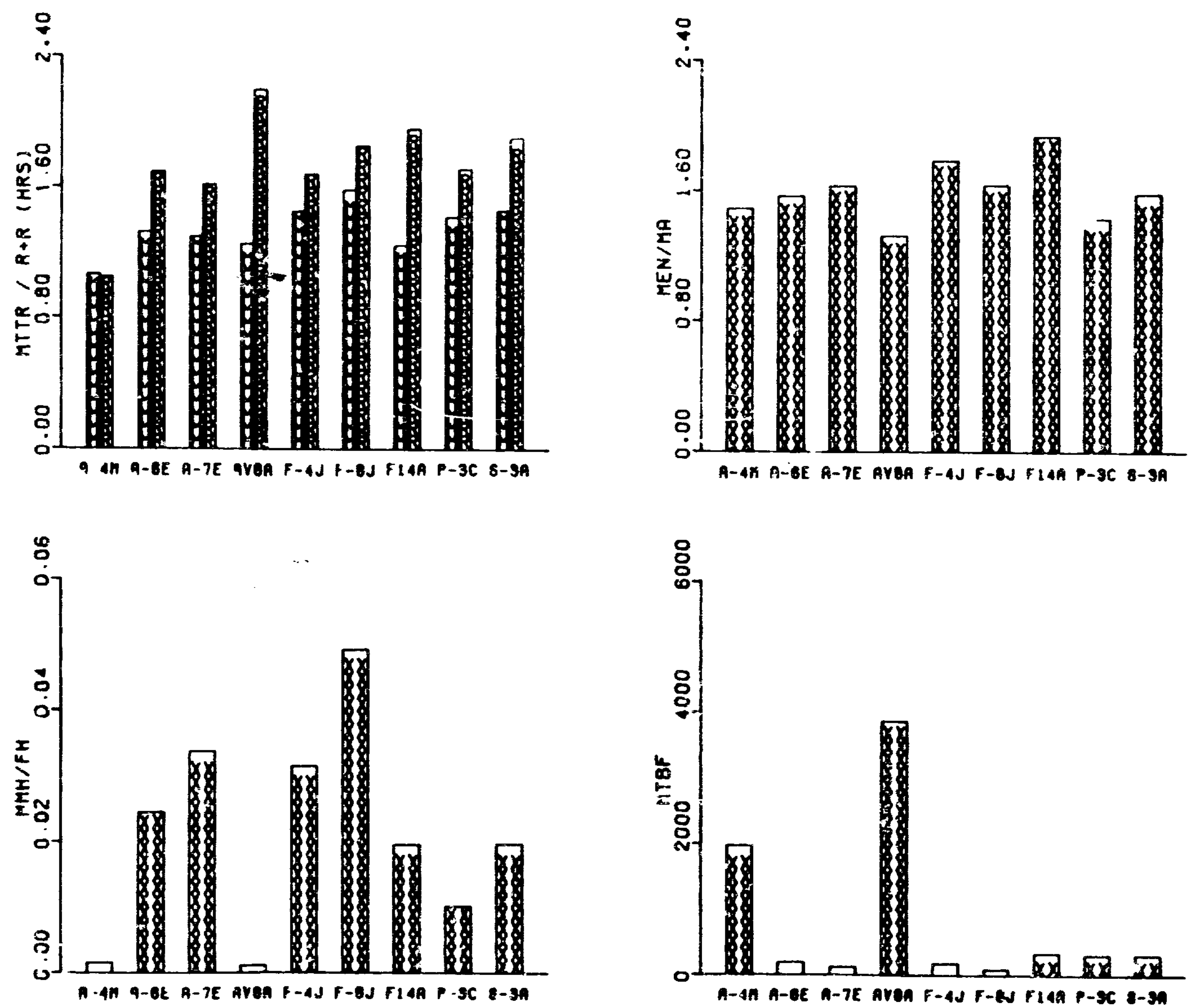


FIGURE 6.49 SELECTED GRAPHICAL DATA - ANGLE OF ATTACK INDICATORS

6.11 FLIGHT REFERENCE/AFCS SYSTEMS

6.11.1 Angle of Attack Indicators (See preceding Table and Figure 6.49)

WORK UNIT CODES

A-4 56861	A-6 51142	A-7 51141	AV-8 51151	F-4 56861
F-8 51191	F-14 56X1C	P-3 51131	S-3 51121	

DISCUSSION

Comments:

The qualitative analysis of these installations appears not to agree with the quantitative data presented here. On the surface, the quantitative figures for R+R reflect that the installation on the A-4M is twice as effective as that of the AV-8A. Yet, the qualitative analysis, while rating all the installations at least "good", recommends the installation on the AV-8A as one that should be emulated on all aircraft. In this case, the AV-8A time is based on one documented occurence in an 18 month period, while the A-4M average is based on only 13 actions for the same period. Consequently, both samples were considered statistically invalid. For comparison, the A-7E data was compiled from 178 actions, a much better sample size for this analysis. All other R+R times attest to the equity of the installations.

Recommendations:

Movement of handles, switches, cowls or guards to gain access to equipment should be avoided. Adherence to this principle during installation design would have negated the need to move the Landing Gear handle on the A-4M to the "up" position to affect removal of the AOA indicator.

Require face plates to be part of the instrument thus eliminating separate removal as on the A-7.

Built In Test (BIT) should be a minimum requirement on all new procurement thus eliminating PGSE requirements (A-7, F-8), which often complicate maintenance rather than simplifying it.

TABLE 6.50 MAINTENANCE DATA - ANGLE OF ATTACK TRANSDUCER/TRANSMITTER

WORK UNIT CODES

A-4	N/A	A-6	N/A	A-7	51142	AV-8	51152	F-4	56865
F-8	51193	F-14	56X1D	P-3	N/A	S-3	51122		

ORGANIZATIONAL LEVEL

A/C	FLIGHT HOURS	MFHBMA	MA/FH X10-3	MTTR	MMH/MA	MEN/MA	MMH/FH	R+R	O+I MTBF
A-4M	35,571								
A-6E	87,564								
A-7E	159,611	114.1	8.8	1.99	3.68	1.8	.032	2.89	153
AV-8A	19,396	269.4	3.7	2.44	3.77	1.5	.014	4.00	388
F-4J	115,070	64.4	15.5	1.81	3.43	1.9	.053	2.03	90
F-8J	18,317	36.0	27.8	1.53	2.65	1.7	.074	2.13	57
F-14A	51,286	240.8	4.2	1.66	3.30	2.0	.014	1.96	369
P-3C	125,860								
S-3A	60,552	251.3	4.0	2.34	5.04	2.2	.020	2.56	439

INTERMEDIATE LEVEL

A/C	FLIGHT HOURS	MFHBMA	MA/FH X10-3	MTTR	MMH/MA	MEN/MA	MMH/FH
A-4M	35,571						
A-6E	87,564						
A-7E	159,611	275.7	3.6	2.41	2.49	1.0	.009
AV-8A	19,396	692.7	1.4	0.33	0.40	1.2	.001
F-4J	115,070	91.3	11.0	2.77	3.39	1.2	.037
F-8J	18,317	104.7	9.6	1.63	1.99	1.2	.019
F-14A	51,286	899.8	1.1	0.50	0.50	1.0	.001
P-3C	125,860						
S-3A	60,552	890.5	1.1	0.38	0.39	1.0	.000

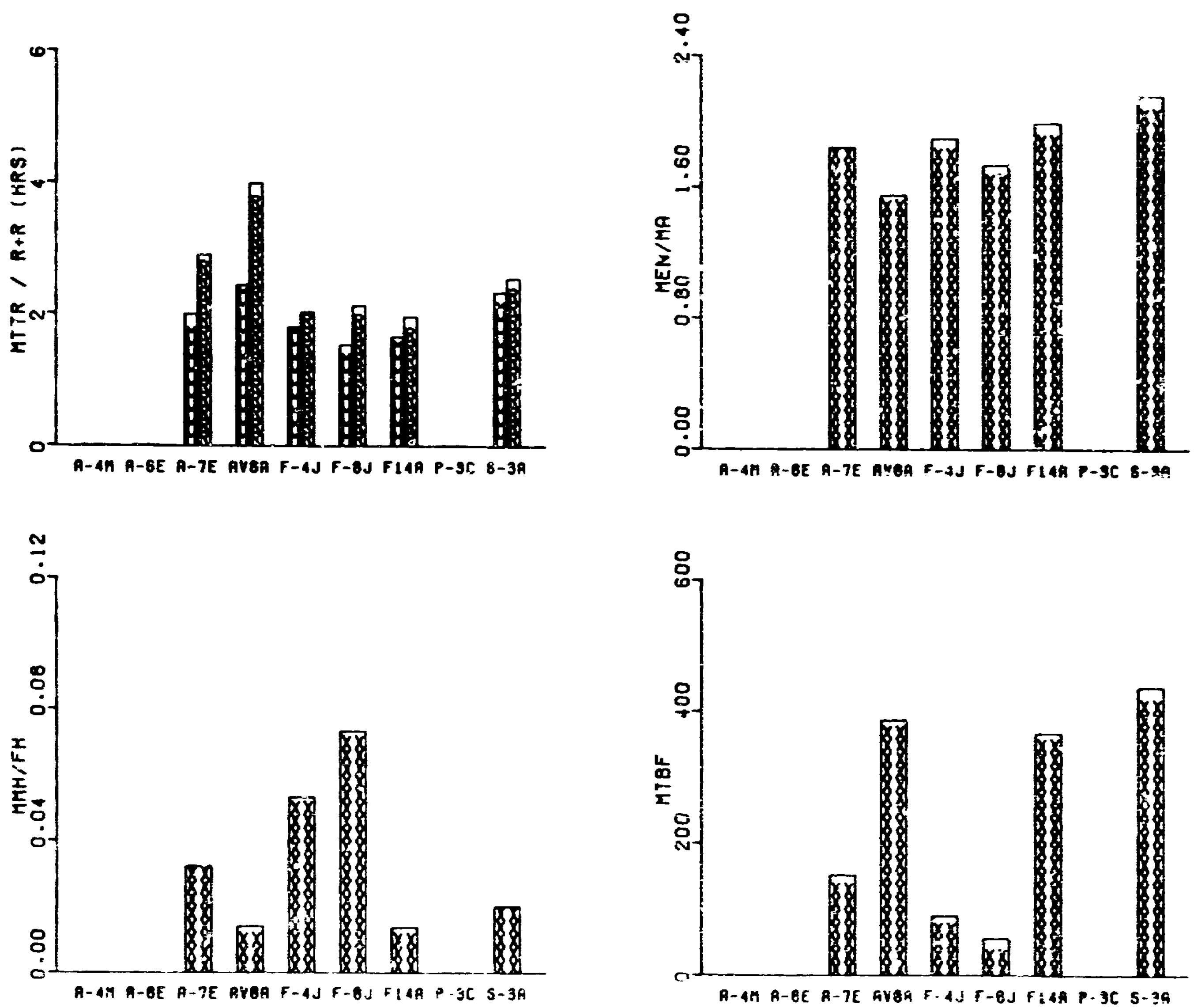


FIGURE 6.50 SELECTED GRAPHICAL DATA - ANGLE OF ATTACK TRANSDUCER/TRANSMITTER

6.11.2 Angle of Attack Transducer/Transmitter (See preceding Table and Figure 6.50)

WORK UNIT CODES

A-4 N/A	A-6 N/A	A-7 51142	AV-8 51152	F-4 56865
F-8 51193	F-14 56X1D	P-3 N/A	S-3 51122	

DISCUSSION

Comments:

The quantitative data substantiates the qualitative analyses throughout this grouping. The high R+R time recorded for the AV-8A is based on 21 actions and the elapsed maintenance time (EMT) is representative of the qualitative evaluation, i.e., use of 14 screws to secure a panel, the need to cut and subsequently replace wire bundle tie wraps, and even with the access panel removed, marginal accessibility to the four mounting bolts and electrical connector. In the case of the A-7E (substantially lower than the AV-8A, but above the average) poor location and a lengthy after installation functional check add significantly to the task time. The two installations with the best R+R times, F-4J and F-14A, do not require use of peculiar ground support equipment (PGSE) to accomplish the after installation checks and, in fact, the F-14A employs a BIT check to expedite the functional test of the system - a real time saver.

Recommendations:

Eliminate need to remove tie wraps from wire bundles to accomplish an R+R action.

Utilize probe rather than vane type installations whenever possible to reduce alignment time and PGSE requirements.

Locate the Transducer in an area where it will not be susceptible to damage by routine cockpit entry or egress by crew/maintenance personnel.

Require BIT provisions satisfy after installation servicability check requirements, eliminating PGSE needs.

Require that all access panel screws or mounting bolts be the same physical size.

TABLE 6.51 MAINTENANCE DATA - REMOTE COMPASS TRANSMITTERS

WORK UNIT CODES

A-4	56X11	A-6	N/A	A-7	56X11	AV-8	51614	F-4	56X11
F-8	N/A	F-14	564E2	P-3	N/A	S-3	N/A		

ORGANIZATIONAL LEVEL

A/C	FLIGHT HOURS	MFHBMA	MA/FH X10-3	MTTR	MMH/MA	MEN/MA	MMH/FH	R+R	O+I MTBF
A-4M	35,571	1,693.9	0.6	6.90	14.87	2.2	.009	8.03	2,371
A-6E	87,564								
A-7E	159,611	665.0	1.5	3.90	7.73	2.0	.012	4.40	956
AV-8A	19,396	440.8	2.3	7.26	15.39	2.1	.035	8.00	882
F-4J	115,070	179.0	5.6	4.21	9.21	2.2	.051	5.36	273
F-8J	18,317								
F-14A	51,286	502.8	2.0	3.09	7.22	2.3	.014	5.13	1,068
P-3C	125,860								
S-3A	60,552								

INTERMEDIATE LEVEL

A/C	FLIGHT HOURS	MFHBMA	MA/FH X10-3	MTTR	MMH/MA	MEN/MA	MMH/FH
A-4M	35,571	2,371.4	0.4	1.08	1.75	1.6	.001
A-6E	87,564						
A-7E	159,611	3,129.6	0.3	1.34	1.34	1.0	.000
AV-8A	19,396	1,212.3	0.8	0.65	0.80	1.2	.001
F-4J	115,070	590.1	1.7	0.69	0.78	1.1	.001
F-8J	18,317						
F-14A	51,286	1,424.6	0.7	0.75	0.93	1.2	.001
P-3C	125,860						
S-3A	60,552						

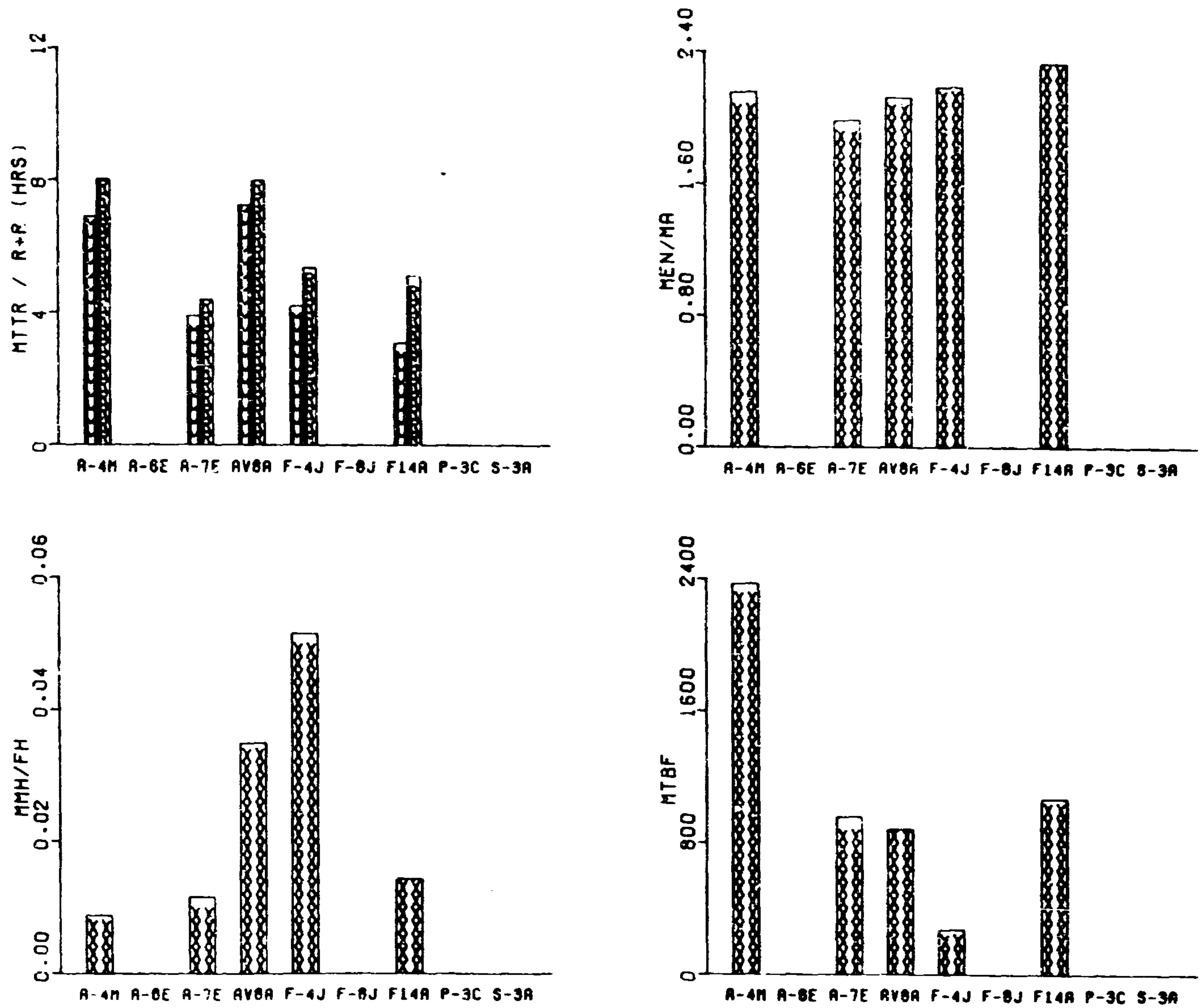


FIGURE 6.51 SELECTED GRAPHICAL DATA - REMOTE COMPASS TRANSMITTERS

6.11.3 Remote Compass Transmitters (See preceding Table and Figure 6.51)

WORK UNIT CODES

A-4 56X11	A-6 N/A	A-7 56X11	AV-8 51614	F-4 56X11
F-8 N/A	F-14 564E2	P-3 N/A	S-3 N/A	

DISCUSSION

Comments:

A review of the Qualitative Maintenance Experience Handbook readily reveals the reasons for the excessive disparagement between the high and low R+R times, i.e., use of sealants on panels and screwheads, potting compound on screws, lack of hand and tool access, use of terminal strips rather than connectors, access for one hand operation only, and excessive use of High Torque screws. All adversely impact maintainability and should be avoided during design.

Recommendations:

Use moisture proof cable connectors rather than open terminal strips thus eliminating need to apply potting compound to screws.

If area is susceptible to moisture collection, use a drain hole technique to aid dissipation rather than seal and pot screws/panels to avoid leaks or shorting of wires.

Use form in place gaskets for panels, similar to MIL-S-8802, rather than applying sealant on the exterior surface of panels and screw heads.

Require sufficient access to accommodate two hands and needed tools and eliminate "blind" removal of screws. This would also decrease the rate of lost or dropped parts.

Require design to determine alternate locations for Remote Compass Transmitters other than high stress areas, which require excessive numbers of High Torque screws, or the top of the Vertical Stabilizer which is not accessible without a high maintenance stand and hardly ever accessible on shipboard.

TABLE 6.52 MAINTENANCE DATA - ATTITUDE DIRECTION INDICATOR

WORK UNIT CODES

A-4	N/A	A-6	N/A	A-7	71X1R	AV-8	51113	F-4	56X14
F-8	51163	F-14	N/A	P-3	73134	S-3	N/A		

ORGANIZATIONAL LEVEL

A/C	FLIGHT HOURS	MFHBMA	MA/FH X10-3	MTTR	MMH/MA	MEN/MA	MMH/FH	R+R	O+I MTBF
A-4M	35,571								
A-6E	87,564								
A-7E	159,611	62.1	16.1	1.34	2.59	1.9	.042	1.73	160
AV-8A	19,396	100.5	10.0	1.50	2.75	1.8	.027	2.96	187
F-4J	115,070	8,219.3	0.1	0.96	1.82	1.9	.000	4.00	16,439
F-8J	18,317	64.5	15.5	1.42	2.26	1.6	.035	2.21	165
F-14A	51,286								
P-3C	125,860	123.6	8.1	1.29	1.91	1.5	.015	1.61	262
S-3A	60,552								

INTERMEDIATE LEVEL

A/C	FLIGHT HOURS	MFHBMA	MA/FH X10-3	MTTR	MMH/MA	MEN/MA	MMH/FH
A-4M	35,571						
A-6E	87,564						
A-7E	159,611	177.7	5.6	3.10	3.26	1.1	.018
AV-8A	19,396	380.3	2.6	0.53	0.62	1.2	.002
F-4J	115,070						
F-8J	18,317	241.0	4.1	1.47	1.58	1.1	.007
F-14A	51,286						
P-3C	125,860	331.2	3.0	0.13	0.15	1.2	.000
S-3A	60,552						

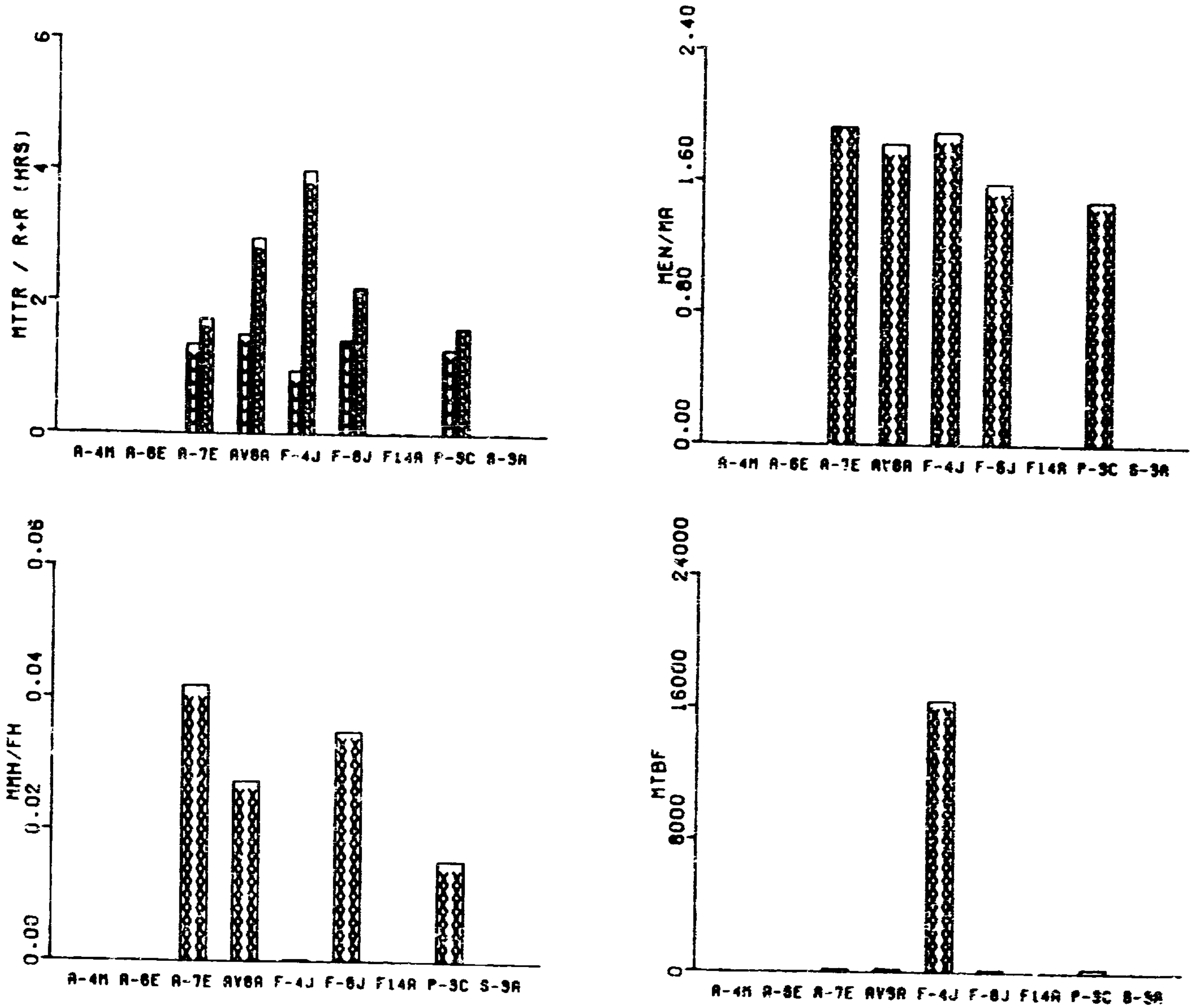


FIGURE 6.52 SELECTED GRAPHICAL DATA - ATTITUDE DIRECTION INDICATOR

6.11.4 Attitude Direction Indicator (See preceding Table and Figure 6.52)

WORK UNIT CODES

A-4 N/A	A-6 N/A	A-7 71X1R	AV-8 511:3	F-4 56X14
F-8 51163	F-14 N/A	P-3 73134	S-3 N/A	

DISCUSSION

Comments:

The high R+R time reflected for the F-4J is not considered significant since it represents only one action during the 18 month period surveyed. The AV-8A R+R value is based on 60 actions and the nearly three hours average time required per action is due to marginal access, the need to remove an adjacent equipment panel, and the fact that the unit must be removed from the rear of the instrument panel. All factors adversely impact the elapsed time required by maintenance to accomplish the task.

Recommendations:

Require that all instrument panel installations be removable from the front of the panel.

Encourage use of rack and panel connectors and further development thereof.

Eliminate even the occasional need to remove adjacent equipment or panels to gain access to units being removed.

Require BIT provisions satisfy after installation servicability check requirements.

TABLE 6.53 MAINTENANCE DATA - GYROSCOPE ASSEMBLIES

WORK UNIT CODES

A-4	56851	A-6	56882	A-7	N/A	AV-8	N/A	F-4	56X13
F-8	N/A	F-14	N/A	P-3	57381	S-3	57364		

ORGANIZATIONAL LEVEL

A/C	FLIGHT HOURS	MFHBMA	MA/FH X10-3	MTTR	MMH/MA	MEN/MA	MMH/FH	R+R	O+I MTBF
A-4M	35,571	35,571.0	0.0	2.80	6.90	2.5	.000		35,571
A-6E	87,564	126.5	7.9	1.16	1.78	1.5	.014	1.55	413
A-7E	159,611								
AV-8A	19,396								
F-4J	115,070	19,178.3	0.1	1.33	2.42	1.8	.000	3.00	57,535
F-8J	18,317								
F-14A	51,286								
P-3C	125,860	648.8	1.5	2.11	3.40	1.6	.005	2.41	1,187
S-3A	60,552	62.2	16.1	1.66	2.82	1.7	.045	2.80	39

INTERMEDIATE LEVEL

A/C	FLIGHT HOURS	MFHBMA	MA/FH X10-3	MTTR	MMH/MA	MEN/MA	MMH/FH
A-4M	35,571	35,571.0	0.0	1.00	2.00	2.0	.000
A-6E	87,564	315.0	3.2	1.23	1.57	1.3	.005
A-7E	159,611						
AV-8A	19,396						
F-4J	115,070	57,535.0	0.0	1.50	2.00	1.3	.000
F-8J	18,317						
F-14A	51,286						
P-3C	125,860	1,176.3	0.9	1.66	1.94	1.2	.002
S-3A	60,552	60.6	16.5	2.28	3.78	1.7	.062

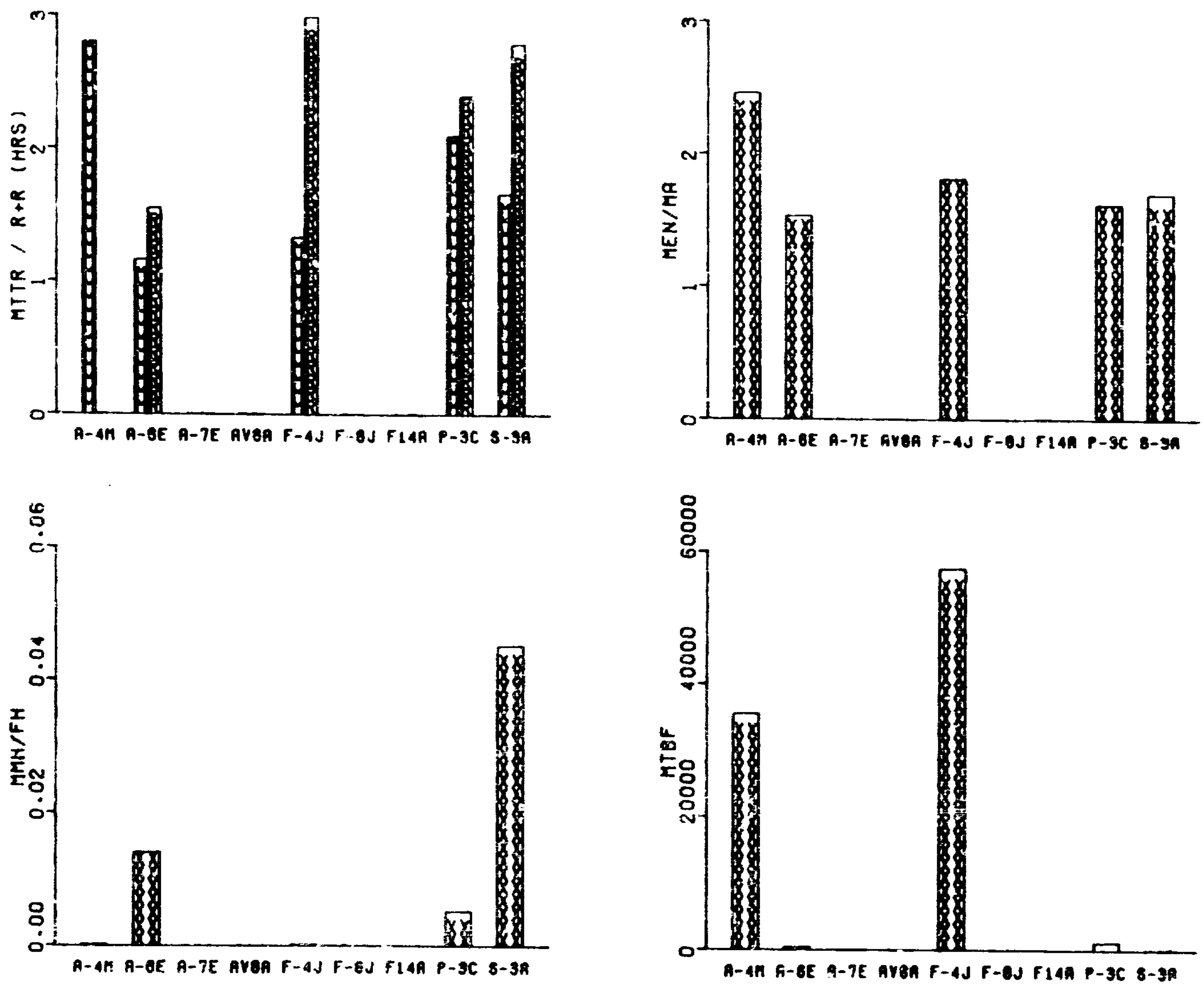


FIGURE 6.53 SELECTED GRAPHICAL DATA - GYROSCOPE ASSEMBLIES

6.11.5 Gyroscope Assemblies (See preceding Table and Figure 6.53)

WORK UNIT CODES

A-4 56851	A-6 56882	A-7 N/A	AV-8 N/A	F-4 56X13
F-8 N/A	F-14 N/A	P-3 57381	S-3 57364	

DISCUSSION

Comments:

This grouping contains a mix of Flight Reference System (FRS) gyros and Automatic Flight Control System (AFCS) gyroscopic assemblies (P-3/S-3) since both are similar in size, mounting and connection. However, the comparison must end there. The AFCS functional check requirements are far more time consuming than the FRS checks and this must be taken into account when evaluating the data presented here.

Only three of the data items concerning Remove and Replace time are considered statistically valid. Zero actions against the A-4M during the July, 1975 to December, 1976 time period is an outstanding testament to reliability of the equipment. The one action recorded for the F-4J in over 100,000 flying hours makes that value statistically invalid but is outstanding performance nonetheless.

The A-6E, P-3C and S-3A installations possessed outstanding access, a minimum of connectors and simple mounting. Functional/Operational check requirements varied somewhat and the differences account for the spread in the R+R elapsed maintenance time (EMT).

The F-4J installation (invalid sample) and after installation checks must be commented on even though the R+R time reflected here is not representative of the true time required to complete the action. To remove the Roll and Pitch Gyro on the F-4, the technician must gain access to the rear cockpit, loosen 14 fasteners, remove a panel. disconnect cabling to the AFCS, Nav Computer and Data Link Controls, remove two connectors to the gyro and three mounting bolts. All actions are accomplished below the left hand console. As a consequence of extensive disconnection of adjacent system electrical connectors, functional checks must be provided on all. A highly unsatisfactory condition.

Recommendations:

Force elimination of the need to remove non-associated equipments to accomplish R+R of WRA's.

Encourage use of rack and panel connectors and further development thereof.

Require BIT/BITE provisions satisfy requirements for after installation serviceability/functional checks.

Whenever possible establish cockpit access from the outside of the airframe, via panels, doors, etc., thus reducing the difficulty encountered with cockpit floor - under console installations.

TABLE 6.54 MAINTENANCE DATA - AIR DATA COMPUTERS

WORK UNIT CODES

A-4	56550	A-6	565A0	A-7	73A61	AV-8	56990	F-4	56454
F-8	65Y1Y	F-14	56X18	P-3	56461	S-3	56711		

ORGANIZATIONAL LEVEL

A/C	FLIGHT HOURS	MFHBMA	MA/FH X10-3	MTTR	MMH/MA	MEN/MA	MMH/FH	R+R	O+I MTBF
A-4M	35,571	329.4	3.0	3.09	6.27	2.0	.019	4.04	697
A-6E	87,564	473.3	2.1	1.91	3.74	2.0	.008	2.34	1,055
A-7E	159,611	36.4	27.5	1.23	2.18	1.8	.060	1.62	82
AV-8A	19,396	50.9	19.6	1.72	3.42	2.0	.067	3.01	96
F-4J	115,070	29.5	33.9	2.44	4.78	2.0	.162	2.87	40
F-8J	18,317	185.0	5.4	2.07	3.87	1.9	.021	2.52	374
F-14A	51,286	326.7	3.1	2.28	3.94	2.6	.018	3.91	801
P-3C	125,860	1,338.9	0.7	1.86	3.00	1.6	.002	2.13	2,098
S-3A	60,552	31.5	31.8	1.25	2.04	1.6	.065	1.88	76

INTERMEDIATE LEVEL

A/C	FLIGHT HOURS	MFHBMA	MA/FH X10-3	MTTR	MMH/MA	MEN/MA	MMH/FH
A-4M	35,571	602.9	1.7	6.31	9.98	1.6	.017
A-6E	87,564	951.8	1.1	5.99	9.84	1.6	.010
A-7E	159,611	77.1	13.0	4.75	5.78	1.2	.075
AV-8A	19,396	87.4	11.4	6.95	9.41	1.4	.108
F-4J	115,070	39.2	25.5	5.74	8.30	1.4	.212
F-8J	18,317	327.1	3.1	1.83	2.26	1.2	.007
F-14A	51,286	657.5	1.5	3.86	4.57	1.2	.007
P-3C	125,860	2,677.9	0.4	1.39	1.52	1.1	.001
S-3A	60,552	66.9	14.9	3.57	6.05	1.7	.090

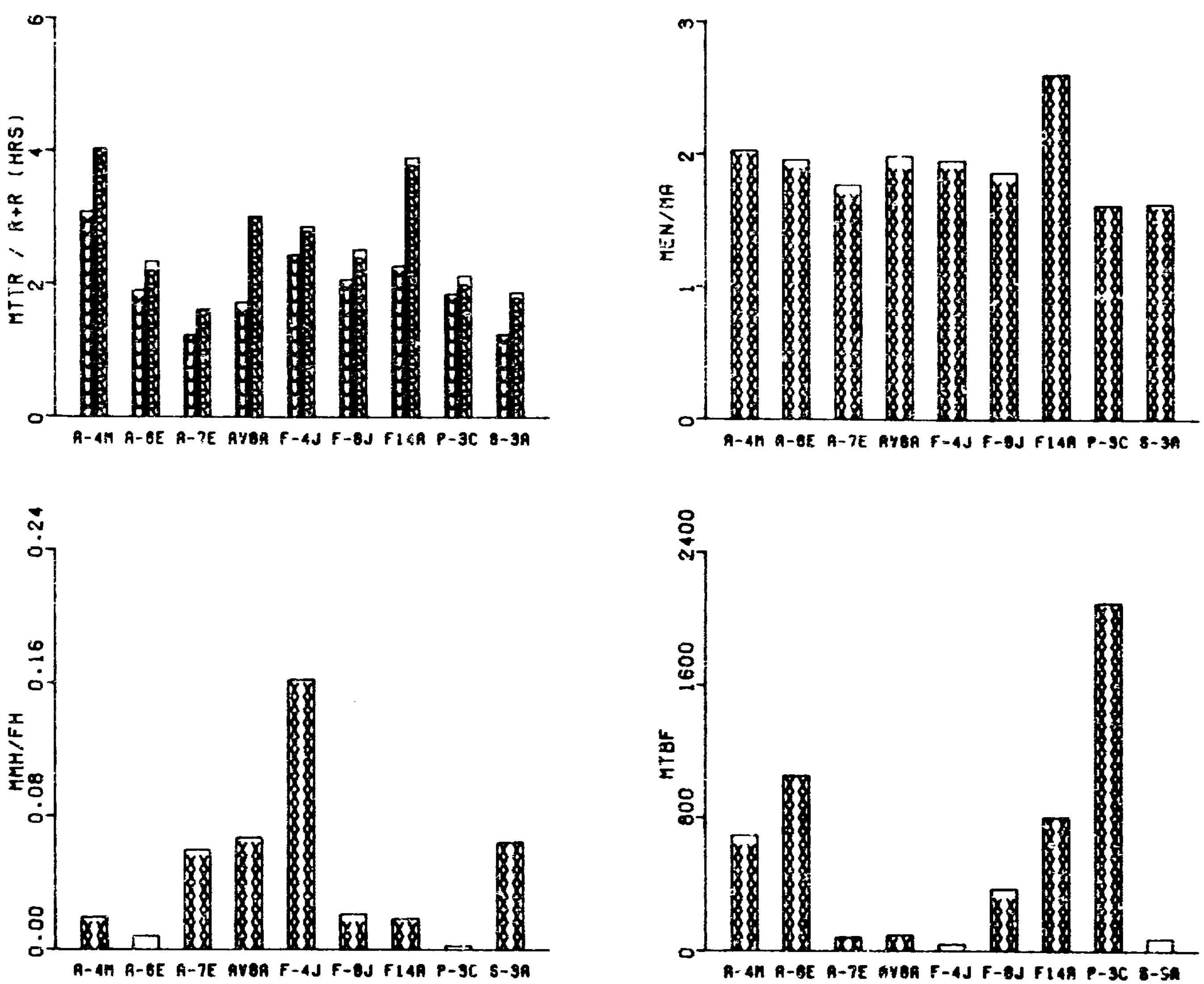


FIGURE 6.54 SELECTED GRAPHICAL DATA - AIR DATA COMPUTERS

6.11.6 Air Data Computers (See preceding Table and Figure 6.54)

WORK UNIT CODES

A-4 56550	A-6 565A0	A-7 73A61	AV-8 56990	F-4 56454
F-8 65Y1Y	F-14 56X18	P-3 56461	S-3 56711	

DISCUSSION

Comments:

The qualitative assessments of these installations are supported by the numerical data presented here. For example, the A-4M was rated as a poor installation because of the unit's location in a highly congested area, the need to bend pitot and static lines to effect removal, and the difficulty in removing the two outside bolts and the unit itself. For the F-14A, the biggest drawback is the 41 Calfax fasteners in the access panel which add significantly to the task time. Possibly the worst installation is on the F-4J where, in order to remove the ADC, the ejection seat and an RT unit (radio) must be removed. It is doubtful that the R+R time reflected here includes the time to remove, replace and checkout the seat and radio. At the other extreme is the S-3A installation which only requires loosening two retainer lock lugs to remove the ADC.

Recommendations:

Force elimination of the need to remove/disturb non-associated equipments to accomplish R+R actions.

Reduce the quantity of fasteners requiring removal to gain access. Reduction can be accomplished by: using hinged doors with quick release latches, using quick release fasteners instead of screws, or by breaking large surface panels into several smaller panels held in place with quick release fasteners.

Encourage use of rack and panel connectors and further development thereof.

Whenever possible establish cockpit access from the outside of the airframe, via panels, doors, etc., thus reducing the difficulty encountered with cockpit floor - under console installations.

Require that BIT/BITE provisions satisfy all requirements for after installation serviceability/functional checks, to include integrated systems check, when applicable.

TABLE 6.55 MAINTENANCE DATA - AFCS COMPUTERS/AMPLIFIERS

WORK UNIT CODES

A-4	57512	57514	A-6	N/A	A-7	57575	57576	57577	AV-8
57890	F-4	N/A	F-8	576A4	576C3	F-14	57711	57712	57713
P-3	5738H	S-3	57557						

ORGANIZATIONAL LEVEL

A/C	FLIGHT HOURS	HFHBMA	MA/FH X10-3	MTTR	MMH/MA	MEN/MA	MMH/FH	R+R	O+I MTBF
A-4M	35,571	1,482.1	0.7	3.17	6.19	2.0	.004	2.75	1,976
A-6E	87,564								
A-7E	159,611	31.3	31.9	1.57	3.08	2.0	.098	1.93	46
AV-8A	19,396	31.2	32.1	2.23	4.53	2.0	.145	2.68	49
F-4J	115,070								
F-8J	18,317	30.2	33.1	1.81	3.29	1.8	.109	2.36	44
F-14A	51,286	51,286.0	0.0	1.50	3.00	2.0	.000	3.34	3,205
P-3C	125,860	305.5	3.3	1.91	3.04	1.6	.010	2.85	559
S-3A	60,552	26.6	37.6	1.62	2.78	1.7	.105	2.63	76

INTERMEDIATE LEVEL

A/C	FLIGHT HOURS	HFHBMA	MA/FH X10-3	MTTR	MMH/MA	MEN/MA	MMH/FH
A-4M	35,571	1,422.8	0.7	3.01	4.05	1.3	.003
A-6E	87,564						
A-7E	159,611	74.2	13.5	4.53	5.29	1.2	.071
AV-8A	19,396	63.2	15.8	4.39	6.35	1.4	.101
F-4J	115,070						
F-8J	18,317	56.5	18.3	5.44	7.35	1.4	.135
F-14A	51,286	3,016.8	0.3	6.65	8.29	1.2	.003
P-3C	125,860	452.7	2.2	7.26	8.39	1.2	.019
S-3A	60,552	66.3	15.1	5.69	8.41	1.5	.127

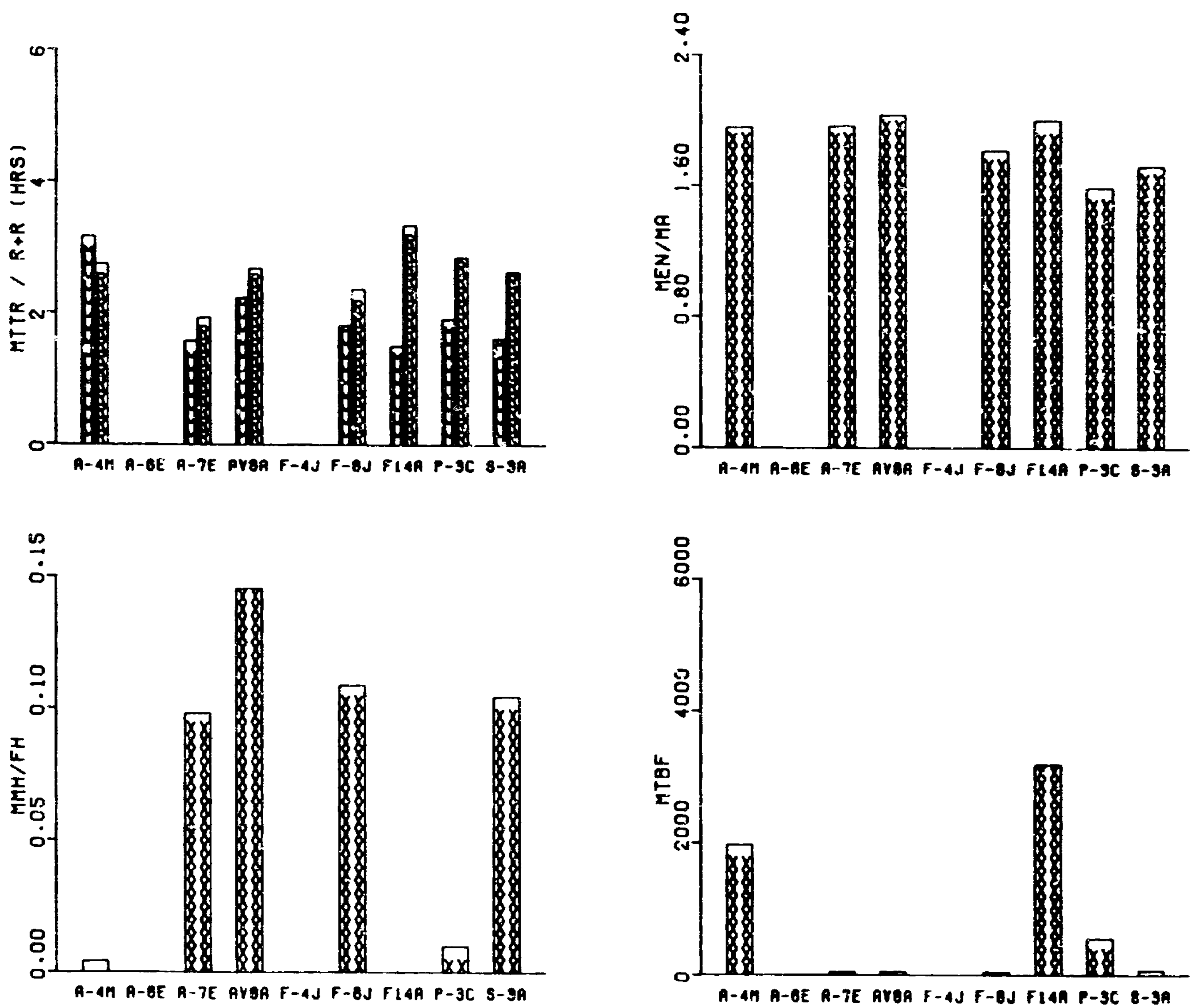


FIGURE 6.55 SELECTED GRAPHICAL DATA - AFCS COMPUTERS/AMPLIFIERS

6.11.7 AFCS Computers/Amplifiers (See preceding Table and Figure 6.55)

WORK UNIT CODES

A-4 57512, 57514	A-6 N/A	A-7 57575, 57576, 57576, 57577	AV-8 57890	F-4 N/A
F-8 576A4, 576C3	F-14 57711, 57712, 57713	P-3 5738H	S-3 57367	

DISCUSSION

Comments:

The R+R time reflected for the F-14A is based on 527 actions documented during the period January, 1975 through June, 1976. The remaining F-14A "O level" data should be disregarded since it is based on only one maintenance action reported during the 18 month period starting July 1, 1975 and ending December 31, 1976.

The high R+R time recorded (F-14A) contains approximately 30 minutes to remove and reinstall a stress panel containing 41 Calfax fasteners (behind which the equipment is located) and lockwire the holddown fasteners. The prime factor however, in elevating all the R+R times is the need to accomplish after installation functional/operational checks. This requirement exists even when BIT is available.

Recommendations:

Restrict the number and type of fasteners/latches associated with frequently used access panels. This can be accomplished by utilizing one or more of the following: use hinged doors with quick release latches, use quick release fasteners instead of screws, or break large surface panels into several smaller ones held in place with quick release fasteners.

Require that BIT/BITE provisions satisfy all requirements for after installation serviceability/functional checks, to include integrated systems check, when applicable.

TABLE 6.56 MAINTENANCE DATA - RECEIVER TRANSMITTERS,COMMUNICATION

WORK UNIT CODES

A-4	63150	A-6	N/A	A-7	63150	AV-8	632M0	F-4	67X1F
F-8	63150	F-14	63150	P-3	632K1	S-3	63271		

ORGANIZATIONAL LEVEL

A/C	FLIGHT HOURS	MFHBMA	MA/FH X10-3	MTTR	MMH/MA	MEN/MA	MMH/FH	R+R	O+I MTBF
A-4M	35,571	55.0	18.2	1.26	2.19	1.7	.040	1.37	83
A-6E	87,564								
A-7E	159,611	27.5	36.3	1.15	2.06	1.8	.075	1.29	41
AV-8A	19,396	17.6	56.8	1.23	2.07	1.7	.118	1.99	37
F-4J	115,070	13.6	73.3	1.60	2.78	1.7	.204	1.74	25
F-8J	18,317	19.3	51.7	1.20	2.25	1.9	.116	1.26	37
F-14A	51,286	25,643.0	0.0	0.40	0.80	2.0	.000	1.48	51,286
P-3C	125,860	41.7	24.0	1.18	1.69	1.4	.040	1.47	67
S-3A	60,552	64.7	15.5	0.98	1.52	1.5	.024	1.54	118

INTERMEDIATE LEVEL

A/C	FLIGHT HOURS	MFHBMA	MA/FH X10-3	MTTR	MMH/MA	MEN/MA	MMH/FH
A-4M	35,571	78.0	12.8	5.85	7.88	1.3	.101
A-6E	87,564						
A-7E	159,611	39.7	25.2	4.13	5.16	1.3	.130
AV-8A	19,396	63.0	15.9	5.31	10.52	2.0	.167
F-4J	115,070	22.8	43.8	5.09	6.27	1.2	.275
F-8J	18,317	35.5	28.2	3.36	4.61	1.4	.130
F-14A	51,286	25,643.0	0.0	3.60	4.60	1.3	.000
P-3C	125,860	59.4	16.8	3.70	4.75	1.3	.080
S-3A	60,552	112.3	8.9	3.81	7.06	1.9	.063

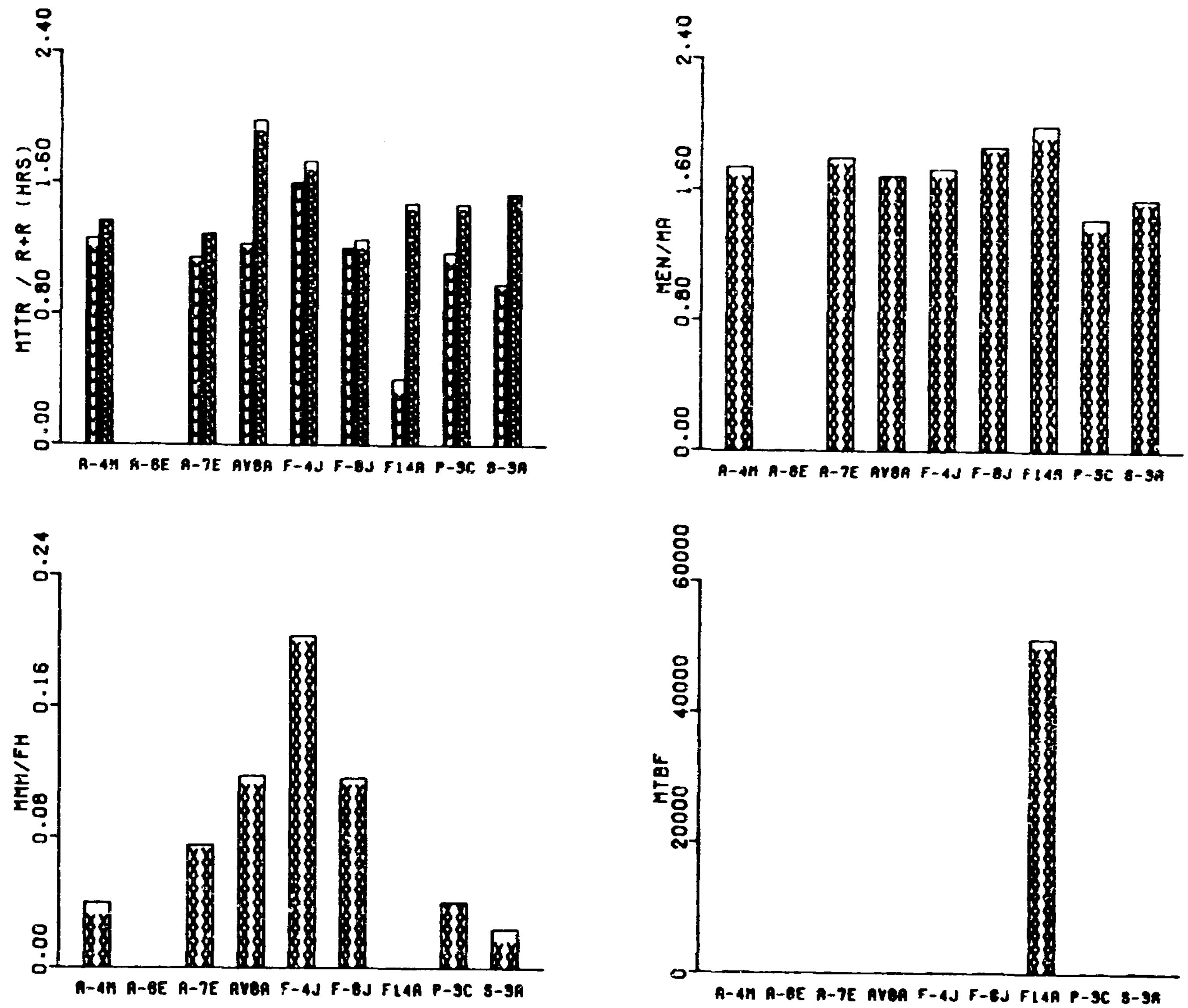


FIGURE 6.56 SELECTED GRAPHICAL DATA - RECEIVER TRANSMITTERS,COMMUNICATION

6.12 COMMUNICATION/IFF SYSTEMS

6.12.1 Receiver Transmitters, Communication (See preceding Table and Figure 6-56)

WORK UNIT CODES

A-4 6315Q	A-6 N/A	A-7 6315Q	AV-8 N/A	F-4 67X1F
F-8 6315Q	F-14 6315Q	P-3 632K1	S-3 63271	

DISCUSSION

Comments:

On initial glance, the R+R times for these components appear to be in line and of little cause for concern. However, a coupling of the cited MTBF with the R+R times indicated that thousands of hours are involved in the minor differences reflected here. The variances in the qualitative data is readily explainable by the qualitative analysis of the installations. The AV-8A requires removal of an access panel inside the confined space of the cockpit and the loosening and displacement of the VHF/FM control. The F-4J requires removal of the ejection seat and the S-3A requires use of a workstand, as does the F-14A. The best installations, quantitatively, are the A-7E and F-8J. Both employ a moderate number (10-15) of quick release fasteners in the access panel and use wing nuts as the means for unit retention. And, although the qualitative analysis is critical of the RT unit location on the F-8, the recommended relocation would only serve to improve the R+R time which, for this time frame, is the lowest in the fleet. Note that except for the R+R data, the F-14A information presented here, for both Organizational and Intermediate levels is considered invalid since the columnar entries are based on only two maintenance actions reported during the July, 1975 through December, 1976 survey period.

Recommendations:

Prohibit removal or disruption of adjacent equipment/hardware to accomplish a removal action.

Require that high frequency removal items be situated in convenient locations to facilitate and expedite maintenance, i.e., installed chest high eliminating need for a workstand, located behind access doors secured with quick release latches, changeable with engines turning, at or forward of the CG (Center of Gravity) to facilitate R+R while at sea when aft sections are spotted over the edge of the deck, etc. A cursory review of the MTBF (predicted or past experience with a similar system) should dictate the location decision.

Require design to consider BIT/BITE as the after installation servicability check eliminating the need for PGSE.

Disallow the designed need for special hand tools for use during the accomplishment of an R+R action.

TABLE 6.57 MAINTENANCE DATA - CONTROLS, COMMUNICATION

WORK UNIT CODES

A-4	63195	A-6	63Y10	A-7	63Y28	AV-8	N/A	F-4	67X1G
F-8	6315U	F-14	N/A	P-3	632K3	S-3	63274		

ORGANIZATIONAL LEVEL

A/C	FLIGHT HOURS	MFHBMA	MA/FH X10-3	MTTR	MMH/MA	MEN/MA	MMH/FH	R+R	O+I MTBF
A-4M	35,571	301.4	3.3	0.80	1.28	1.6	.004	1.22	395
A-6E	87,564	234.1	4.3	1.06	1.82	1.7	.008	1.29	500
A-7E	159,611	122.9	8.1	0.97	1.57	1.6	.013	1.26	248
AV-8A	19,396								
F-4J	115,070	24.8	40.4	1.01	1.74	1.7	.070	1.25	55
F-8J	18,317	45.1	22.2	0.79	1.26	1.6	.028	1.37	67
F-14A	51,286								
P-3C	125,860	280.9	3.6	0.99	1.54	1.5	.005	1.46	905
S-3A	60,552	123.6	8.1	0.98	1.43	1.5	.012	1.49	208

INTERMEDIATE LEVEL

A/C	FLIGHT HOURS	MFHBMA	MA/FH X10-3	MTTR	MMH/MA	MEN/MA	MMH/FH
A-4M	35,571	1,077.9	0.9	2.45	2.97	1.2	.003
A-6E	87,564	621.0	1.6	3.20	3.93	1.2	.006
A-7E	159,611	305.2	3.3	2.60	3.13	1.2	.010
AV-8A	19,396						
F-4J	115,070	58.7	17.0	4.54	5.55	1.2	.094
F-8J	18,317	315.8	3.2	1.71	2.21	1.3	.007
F-14A	51,286						
P-3C	125,660	939.3	1.1	2.77	3.77	1.4	.004
S-3A	60,552	1,164.5	0.9	3.35	3.65	1.1	.003

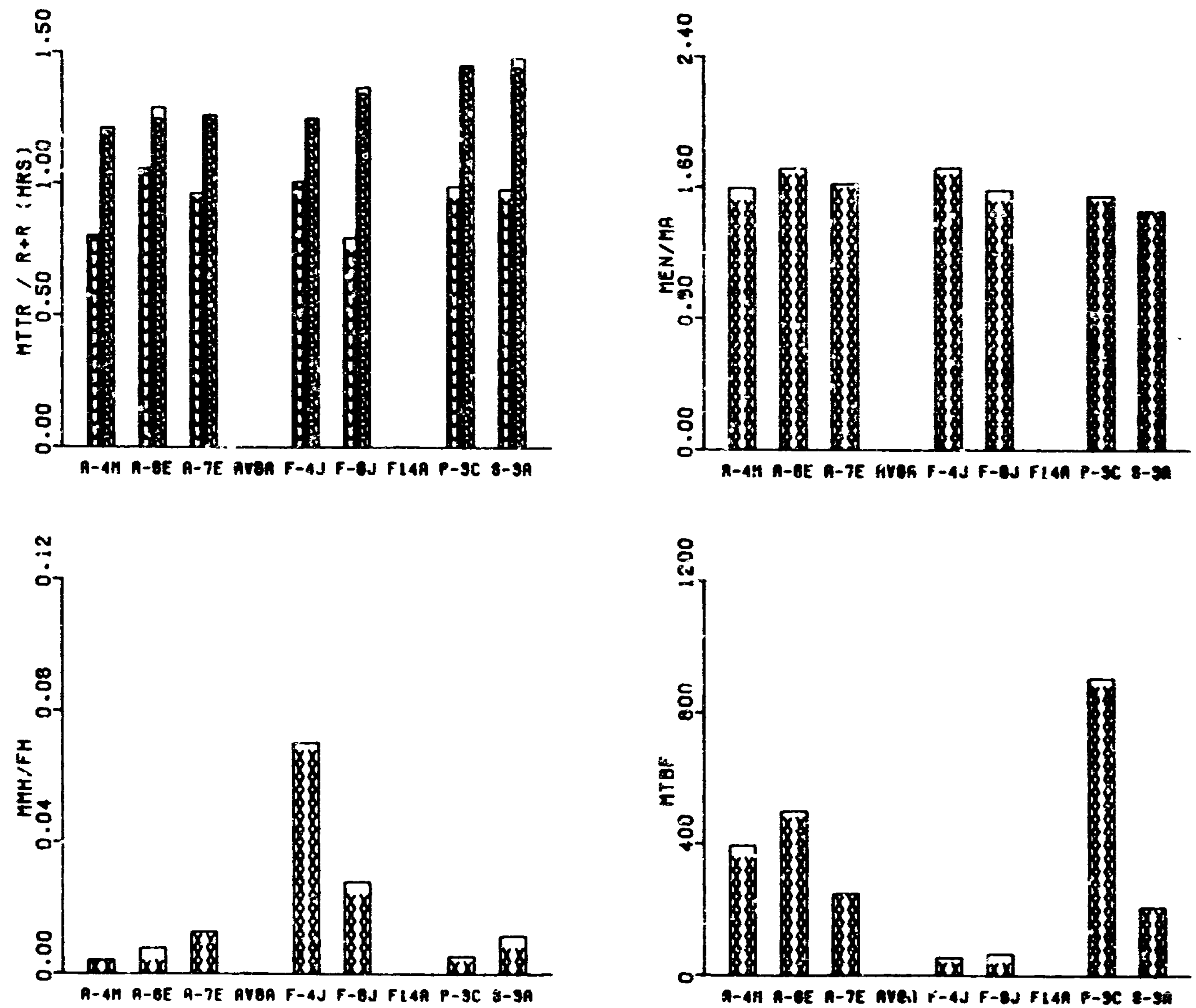


FIGURE 6.57 SELECTED GRAPHICAL DATA - CONTROLS, COMMUNICATION

6.12.2 Controls, Communication (See preceding Table and Figure 6.57)

WORK UNIT CODES

A-4 63155	A-6 63Y1Q	A-7 63Y28	AV-8 N/A	F-4 67X1G
F-8 6315U	F-14 N/A	P-3 632K3	S-3 63274	

DISCUSSION

Comments:

Very little to be concerned about or commented on here. Most installations are optimized with the major differences being the number of Dzus fasteners (four to eight) utilized to secure the controls and the number of connectors mated to the unit. The significant additive factor in the R+R elapsed time is the requirement for a functional/operational check after installation. During the operational/functional check, some systems require that the pre-set channel frequencies be re-set (F-4J and F-8J). Coincidently, the F-4J and F-8J data also reflect the poorest MTBF averages by a substantial margin.

Recommendations:

Require that aircraft cable harness lengths, to all panel/console mounted controls, contain adequate slack to permit the control to clear the console for connector removal, even after a specified number of repairs to the cable. An alternate method would require the use of rack and panel connectors and a continuing program of improvement thereto.

Require that channel frequencies be pre-set at Intermediate level and eliminate need to re-set channels at Organizational level.

TABLE 6.58 MAINTENANCE DATA - IFF R/T UNITS

WORK UNIT CODES

A-4	65341	A-6	N/A	A-7	65341	AV-8	65341	F-4	65321
F-8	65341	F-14	65341	P-3	65321	S-3	65321		

ORGANIZATIONAL LEVEL

A/C	FLIGHT HOURS	MFHBMA	MA/FH X10-3	MTTR	MMH/MA	MEN/MA	MMH/FH	R+R	O+I MTBF
A-4M	35,571	247.0	4.0	2.00	3.63	1.8	.015	1.93	301
A-6E	87,564								
A-7E	159,611	110.2	9.1	1.23	2.24	1.8	.020	1.48	180
AV-8A	19,396	100.0	10.0	1.63	2.99	1.8	.030	1.79	141
F-4J	115,070	368.8	2.7	2.30	4.17	1.8	.011	2.52	365
F-8J	18,317	38.2	26.2	1.37	2.77	2.0	.073	1.69	83
F-14A	51,286	25,643.0	0.0	0.50	1.00	2.0	.000	1.54	17,095
P-3C	125,860	83.7	11.9	1.21	1.78	1.5	.021	1.57	139
S-3A	60,552	232.0	4.3	1.32	2.25	1.7	.010	2.17	369

INTERMEDIATE LEVEL

A/C	FLIGHT HOURS	MFHBMA	MA/FH X10-3	MTTR	MMH/MA	MEN/MA	MMH/FH
A-4M	35,571	231.0	4.3	4.50	5.40	1.2	.023
A-6E	87,564						
A-7E	159,611	162.2	6.2	4.00	5.27	1.3	.033
AV-8A	19,396	106.6	9.4	5.12	7.71	1.5	.072
F-4J	115,070	284.1	3.5	6.73	8.04	1.2	.028
F-8J	18,317	68.3	14.6	5.35	6.32	1.2	.093
F-14A	51,286	7,326.6	0.1	1.50	1.64	1.1	.000
P-3C	125,860	118.7	8.4	5.89	8.15	1.4	.069
S-3A	60,552	334.5	3.0	9.58	13.27	1.4	.040

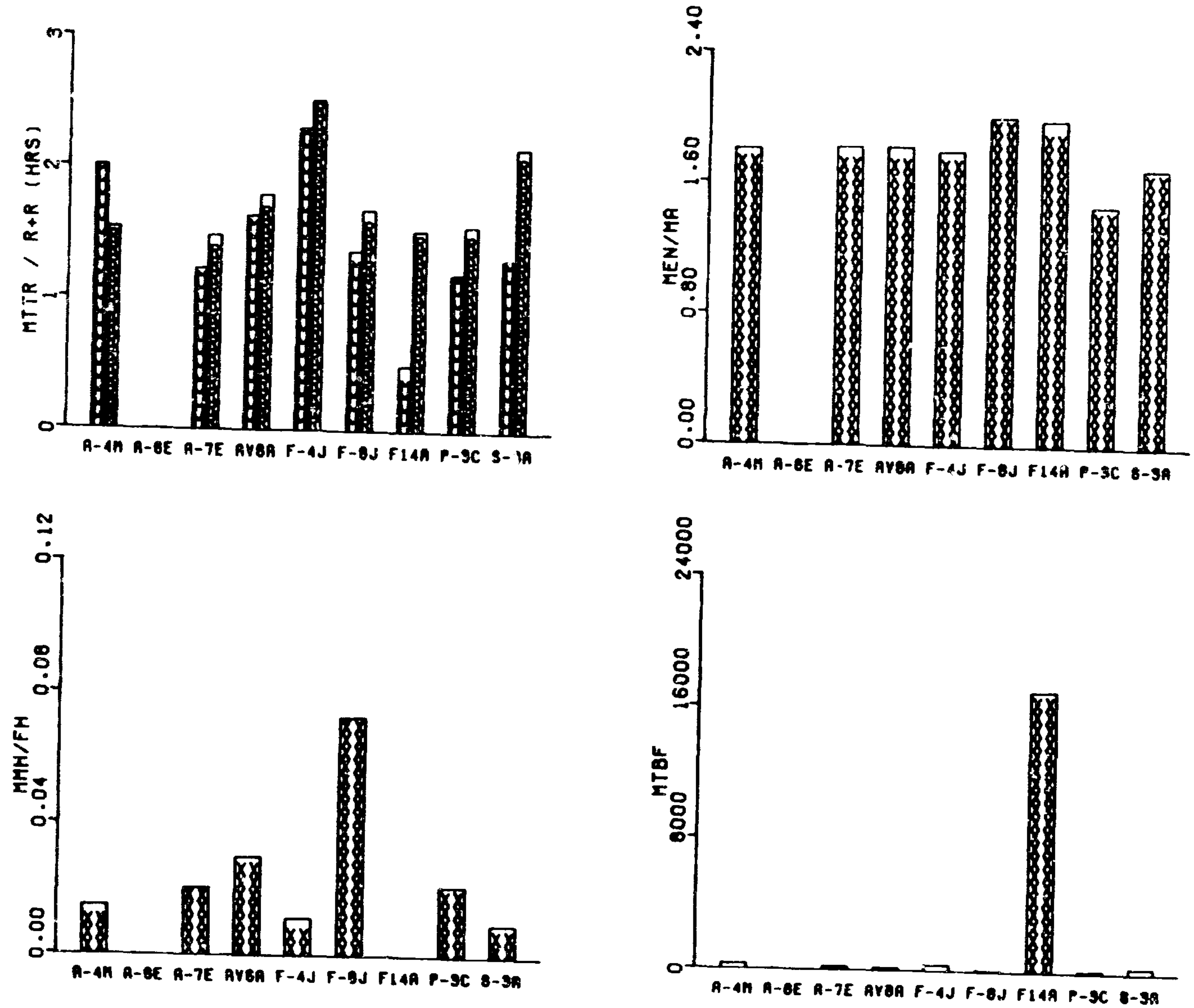


FIGURE 6.58 SELECTED GRAPHICAL DATA - IFF R/T UNITS

6.12.3 IFF R/T Units (See preceding Table and Figure 6.55)

WORK UNIT CODES

A-4 65341	A-6 N/A	A-7 65341	AV-8 65341	F-4 65321
F-8 65341	F-14 65341	P-3 65321	S-3 65321	

DISCUSSION

Comments:

Two systems were surveyed under this grouping. The APX-72 on the A-4M, A-7E, AV-8A, F-8J and F-14A, and the APX-76 on the F-4J, P-3C and S-3A. The qualitative analyses offer no apparent reason for the nearly one hour spread in elapsed time to R+R the APX-76 on the F-4J, P-3C and S-3A. In the case of the F-4J and S-3A the units are located behind access panels/doors but neither require workstands and both were considered to provide good access in an installation typical of most other aircraft. All data concerning the APX-72 were consistent with the analyses and were within a spread of 18 minutes.

Recommendations:

Require all avionic accesses to be hinged with quick release fasteners or latches.

Specify that use of maintenance stands or special tools to gain access to Avionic equipment is undesirable unless the MTBF is elevated to the point that R+R action becomes an infrequent occurrence.

Require that BIT/BITE provisions satisfy all requirements for after installation serviceability/functional checks.

TABLE 6.59 MAINTENANCE DATA - BEARING,DISTANCE AND HEADING INDICATORS

WORK UNIT CODES

A-4	71X1L	A-6	N/A	A-7	N/A	AV-8	71X1L	F-4	71X1L
F-8	71X1L	F-14	71X1L	P-3	N/A	S-3	N/A		

ORGANIZATIONAL LEVEL

A/C	FLIGHT HOURS	MFHBMA	MA/FH X10-3	MTTR	MMH/MA	MEN/MA	MMH/FH	R+R	O+I MTBF
A-4M	35,571	725.9	1.4	1.56	2.70	1.7	.004	1.55	1,547
A-6E	87,564								
A-7E	159,611								
AV-8A	19,396	668.8	1.5	1.01	1.70	1.7	.003	1.42	1,940
F-4J	115,070	263.3	3.8	1.20	1.97	1.6	.007	1.42	572
F-8J	18,317	237.9	4.2	1.43	2.91	2.0	.012	1.26	555
F-14A	51,286	220.1	4.5	0.86	1.51	1.8	.007	1.03	884
P-3C	125,860								
S-3A	60,552								

INTERMEDIATE LEVEL

A/C	FLIGHT HOURS	MFHBMA	MA/FH X10-3	MTTR	MMH/MA	MEN/MA	MMH/FH
A-4M	35,571	1,368.1	0.7	1.17	1.54	1.3	.001
A-6E	87,564						
A-7E	159,611						
AV-8A	19,396	2,155.1	0.5	1.49	1.70	1.1	.001
F-4J	115,070	816.1	1.2	1.01	1.22	1.2	.001
F-8J	18,317	495.1	2.0	1.08	1.18	1.1	.002
F-14A	51,286	657.5	1.5	0.84	0.96	1.1	.001
P-3C	125,860						
S-3A	60,552						

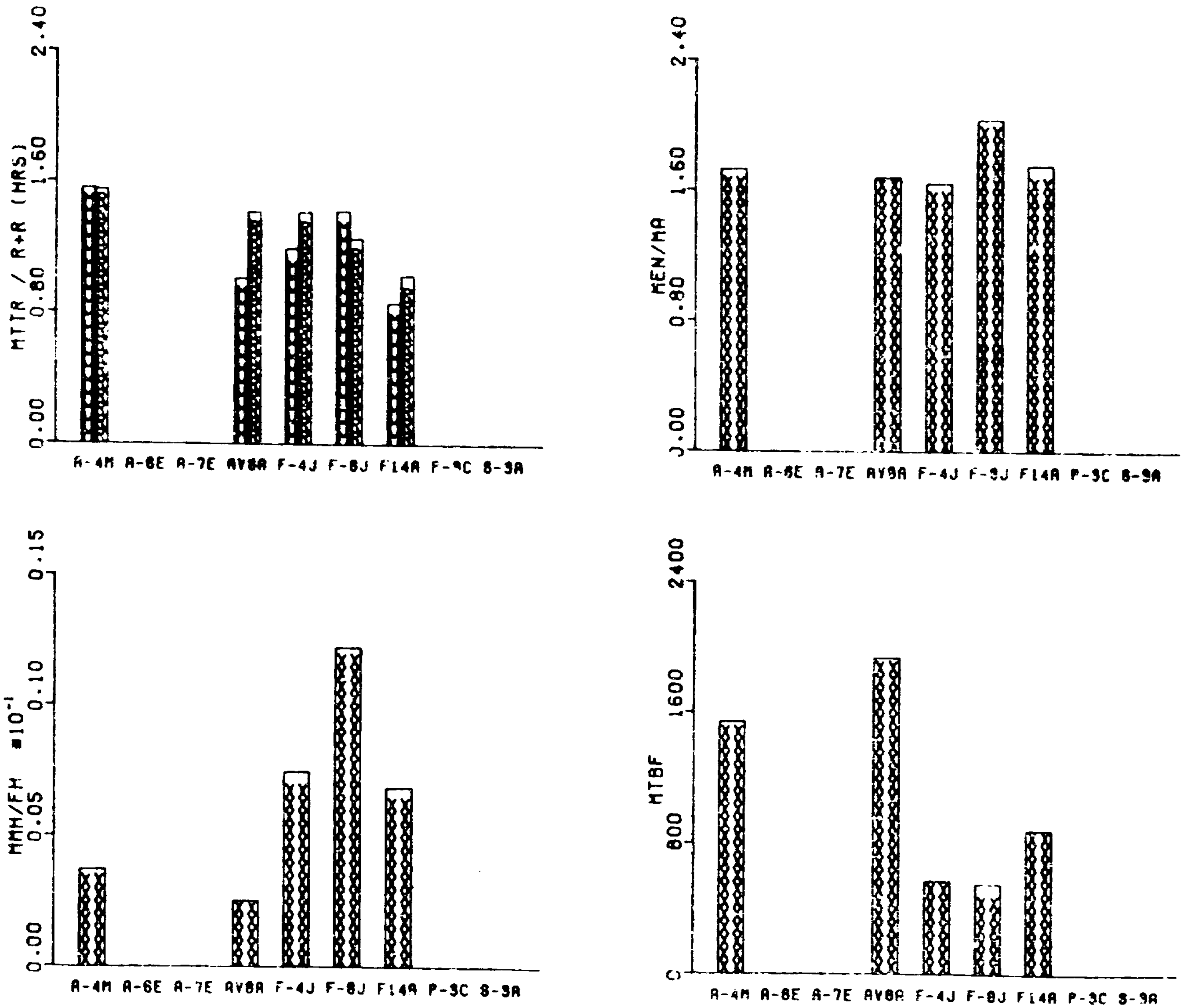


FIGURE 6.59 SELECTED GRAPHICAL DATA - BEARING, DISTANCE AND HEADING INDICATORS

6.13 NAVIGATION SYSTEMS

6.13.1 Bearing, Distance and Heading Indicators (See preceding Table and Figure 6.59)

WORK UNIT CODES

A-4 71X1L	A-6 N/A	A-7 N/A	AV-8 71X1L	F-4 71X1L
F-8 71X1L	F-14 71X1L	P-3 N/A	S-3 N/A	

DISCUSSION

Comments:

All of the installations in this grouping are essentially the same and all concern the ID-663, BDHI. Logically then, both the R+R elapsed time values and the MTBF values should reflect equivalency. Yet, there is over a 30 minute spread in the R+R time and nearly a 1400 hour spread in the MTBF. The difference can only be explained by the environment posed by the various installations and there is insufficient information available here to accomplish an evaluation of that nature.

Recommendations:

Ensure that length and routing of cables allow sufficient slack to permit the unit to be removed an adequate distance from the instrument panel to provide hand and finger access for cable disconnect. (In the case of the AV-8A, the technician must reach behind the instrument panel to disconnect the BDHI prior to unit removal.) An alternate solution to this problem would be to require the use of rack and panel connectors.

TABLE 6.60 MAINTENANCE DATA - TACAN R/T UNITS

WORK UNIT CODES

A-4	713C1	A-6	N/A	A-7	71431	AV-8	718Y1	F-4	67171
F-8	71431	F-14	713C1	P-3	N/A	S-3	N/A		

ORGANIZATIONAL LEVEL

A/C	FLIGHT HOURS	MFHBMA	MA/FH X10-3	MTTR	MMH/MA	MEN/MA	MMH/FH	R+R	O+I MTBF
A-4M	35,571	87.8	11.4	1.64	3.05	1.9	.035	1.59	289
A-6E	87,564								
A-7E	159,611	40.5	24.7	1.27	2.33	1.8	.056	1.35	52
AV-8A	19,396	25.2	39.6	1.44	2.90	2.0	.115	2.16	82
F-4J	115,070	16.2	61.7	1.29	2.30	1.8	.142	1.34	23
F-8J	18,317	12.5	79.9	1.19	2.32	1.9	.185	1.31	22
F-14A	51,286	78.3	12.8	1.14	2.39	2.1	.031	1.59	260
P-3C	125,860								
S-3A	60,552								

INTERMEDIATE LEVEL

A/C	FLIGHT HOURS	MFHBMA	MA/FH X10-3	MTTR	MMH/MA	MEN/MA	MMH/FH
A-4M	35,571	120.2	8.3	2.38	3.63	1.5	.030
A-6E	87,564						
A-7E	159,611	46.4	21.6	4.08	4.88	1.2	.105
AV-8A	19,396	54.8	18.3	3.21	7.94	2.5	.145
F-4J	115,070	19.2	52.2	3.88	5.43	1.4	.284
F-8J	18,317	19.1	52.5	4.32	5.51	1.3	.289
F-14A	51,286	173.3	5.8	2.99	4.66	1.6	.027
P-3C	125,860						
S-3A	60,552						

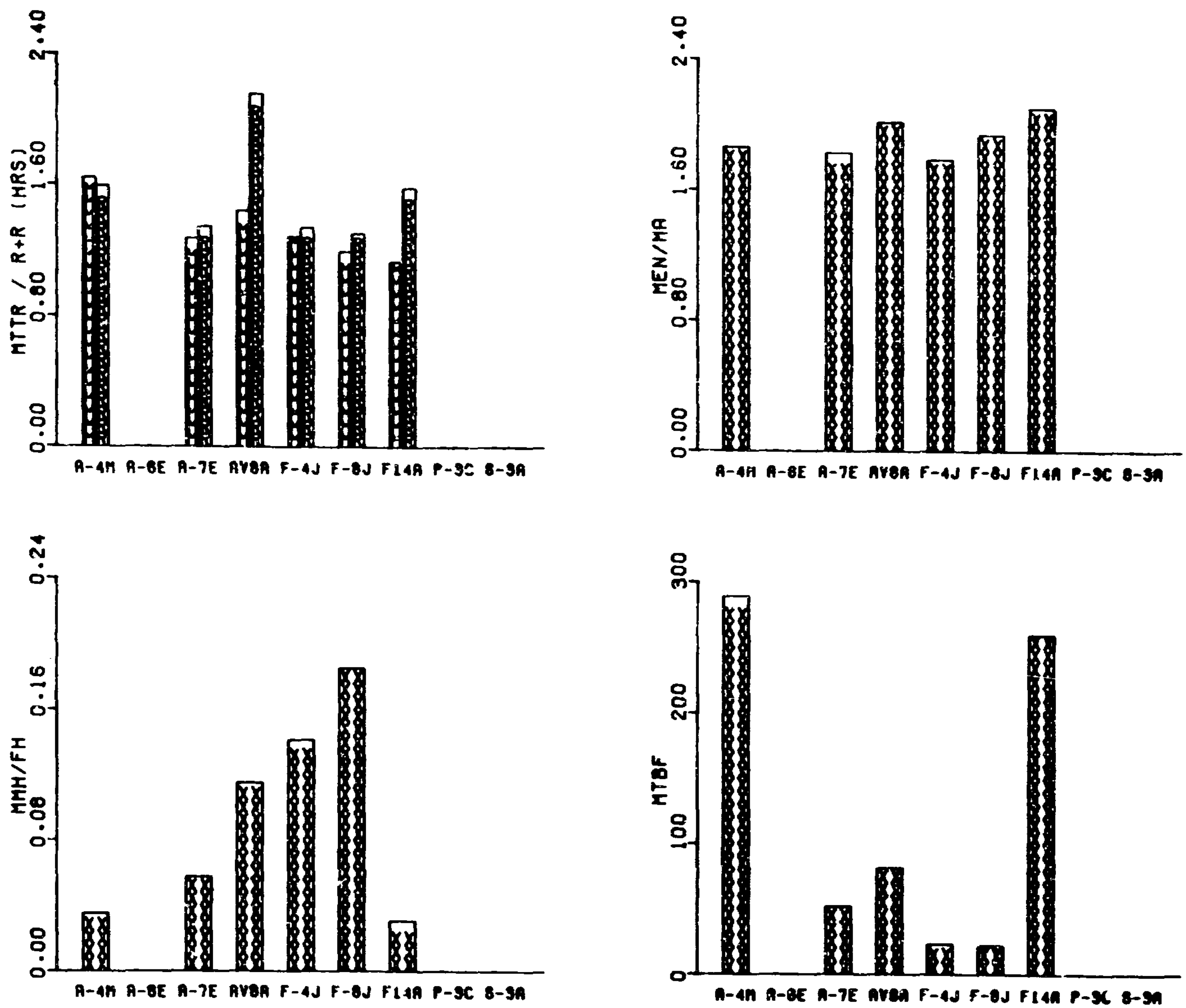


FIGURE 6.60 SELECTED GRAPHICAL DATA - TACAN R/T UNITS

6.13.2 TACAN R/T Units (See preceding Table and Figure [illegible])

WORK UNIT CODES

A-4 713C1	A-6 N/A	A-7 71431	AV-8 718Y1	F-4 67171
F-8 71431	F-14 713C1	P-3 N/A	S-3 713C1	

DISCUSSION

Comments:

The AV-8A installation is not as ineffective as the R+R data indicates. Some loss of efficiency is encountered by the need to remove an access panel secured with twenty-two fasteners and the need to lock wire the retaining nuts. However, the system is equipped with BIT and merely needs an operational check with the base station to insure serviceability after installation. The same could be said of the installation on the S-3A. It is considered, from a maintainability point-of-view, to be the best installation in the grouping with rack and panel connectors, two knurled knob hold downs, extremely easy access and a built in self test. The other installations, in varying employments, require maintenance stands, removal/reinstallation of panel, numerous screws or fasteners, lockwire, door support arms installation, test equipment and an operational/functional check.

Recommendations:

Equipments with low MTBF, such as those reflected here (particularly those considered exceedingly low - F-8J, F-4J, A-7E and AV-8A), should be located behind access doors, not removable panels, and doors should be secured with quick release latches.

Require use of rack and panel connectors.

Specify that BIT/BITE provisions must satisfy all requirements for after installation checks eliminating test equipment needs and operational/functional checks.

TABLE 6.61 MAINTENANCE DATA - RADAR ALTIMETER R/T UNITS

WORK UNIT CODES

A-4	72361	72364	A-6	72361	72364	A-7	72361	72364	AV-8
72281	F-4	72361	72364	F-8	72241	72242	F-14	72281	P-3
N/A	S-3	722H1							

ORGANIZATIONAL LEVEL

A/C	FLIGHT HOURS	MFHBMA	MA/FH X10-3	MTTR	MMH/MA	MEN/MA	MMH/FH	R+R	O+I MTBF
A-4M	35,571	78.9	12.7	1.47	2.61	1.8	.033	1.37	101
A-6E	87,564	18.1	55.3	1.20	2.15	1.8	.119	1.40	30
A-7E	139,611	30.2	33.1	1.29	2.36	1.8	.078	1.42	51
AV-8A	19,396	668.8	1.5	1.94	3.84	2.0	.006	2.39	1,616
F-4J	115,070	28.1	35.5	1.62	2.98	1.8	.106	1.71	36
F-8J	18,317	26.1	38.4	1.20	2.25	1.9	.086	1.28	84
F-14A	51,285	70.3	14.2	1.20	2.38	2.0	.034	1.79	293
P-3C	125,860								
S-3A	60,552	52.8	18.9	0.94	1.39	1.5	.026	1.58	140

INTERMEDIATE LEVEL

A/C	FLIGHT HOURS	MFHBMA	MA/FH X10-3	MTTR	MMH/MA	MEN/MA	MMH/FH
A-4M	35,571	63.5	15.7	4.06	5.01	1.2	.079
A-6E	87,564	20.8	48.1	2.02	2.43	1.2	.117
A-7E	159,611	31.9	31.4	2.16	2.73	1.3	.085
AV-8A	19,396	1,939.6	0.5	3.36	4.36	1.3	.002
F-4J	115,070	24.4	41.0	2.12	2.64	1.2	.108
F-8J	18,317	34.6	28.9	2.62	2.77	1.1	.080
F-14A	51,286	296.5	3.4	1.62	1.86	1.1	.006
P-3C	125,860						
S-3A	60,552	122.8	8.1	4.39	7.57	1.7	.062

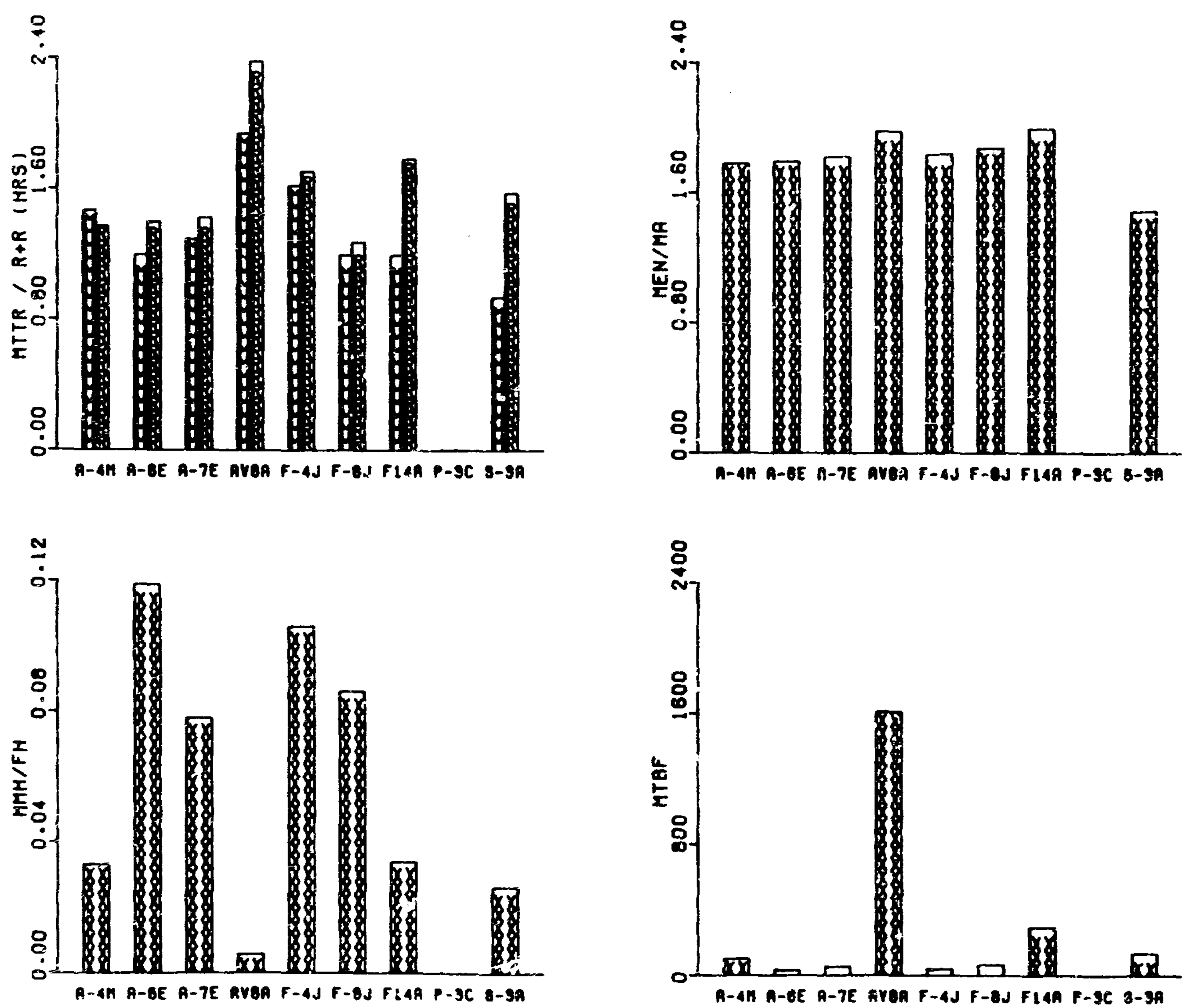


FIGURE 6.61 SELECTED GRAPHICAL DATA - RADAR ALTIMETER R/T UNITS

6.13.3 Radar Altimeter R/T Units (See preceding Table and Figure 6.61)

WORK UNIT CODES

A-4 72361, 72364	A-6 72361, 72364	A-7 72361, 72364	AV-8 722E1	F-4 72361, 72364
F-8 72241, 72242	F-14 722B1	P-3 N/A	S-3 722H1	

DISCUSSION

Comments:

The high R+R elapsed time recorded for the AV-8A is based on only 15 actions, but the time is considered representative of a much larger, more satisfactory, sample. This judgment is based on the information contained in the qualitative analysis which is critical of the number of fasteners used to secure the access panel, of the need to remove the mounting jack prior to removal of the unit (from that item), and of the requirement to disconnect the interface connector and "thread" it through the mounting rack prior to removal of the rack. As a result of these superfluous tasks in the removal/installation action, the advantages gained by BIT is overshadowed. In the case of the F-14A and F-4J, the removal is slowed by having to remove 41 fasteners in two panels (F-14A) and 41 stress fasteners from one access panel (F-4J) to gain access to the component installation. If these excessive, time consuming sub-tasks could be reduced in scope or eliminated, the time to R+R the units involved could be measurably improved.

Recommendations:

Avoid excessive numbers of fasteners that must be removed from panels to gain access to equipment. This can be accomplished by using one or more of the following techniques: use hinged doors with quick release latches rather than removable panels, use quick release fasteners rather than screws, or break large surface panels into several smaller ones held in place with quick release latches or fasteners.

Eliminate the need to remove ancillary equipment, such as mounting racks, to effect removal of a unit unless the entire assembly is considered as one WRA.

Specify that BIT/BITE provisions satisfy all requirements for after installation checks, eliminating test equipment needs and additional operational/functional checks.

Disallow designed access to mounting bolts from adjacent compartments having separate access.

TABLE 6.62 MAINTENANCE DATA - RADAR ALTIMETER INDICATORS

WORK UNIT CODES

A-4	72363	A-6	72362	A-7	72362	AV-8	722B2	F-4	72362
F-8	N/A	F-14	72225	P-3	7236C	S-3	722H2		

ORGANIZATIONAL LEVEL

A/C	FLIGHT HOURS	MFHBMA	MA/FH X10-3	MTTR	MMH/MA	MEN/MA	MMH/FH	R+R	O+I MTBF
A-4M	35,571	988.1	1.0	1.09	1.68	1.5	.002	1.46	2,736
A-6E	87,564	153.6	6.5	1.07	1.79	1.7	.012	1.49	425
A-7E	159,611	153.8	6.5	1.09	1.85	1.7	.012	1.31	409
AV-8A	19,396	746.0	1.3	2.44	3.75	1.5	.005	4.98	1,021
F-4J	115,070	177.6	5.6	1.03	1.55	1.5	.009	1.46	483
F-8J	18,317								
F-14A	51,286	166.5	6.0	1.07	2.10	2.0	.013	1.36	508
P-3C	125,860	201.7	5.0	1.17	1.71	1.5	.008	1.53	536
S-3A	60,552	99.1	10.1	1.13	1.78	1.6	.018	1.53	270

INTERMEDIATE LEVEL

A/C	FLIGHT HOURS	MFHBMA	MA/FH X10-3	MTTR	MMH/MA	MEN/MA	MMH/FH
A-4M	35,571	1,546.6	0.6	1.73	3.96	2.3	.003
A-6E	87,564	385.7	2.6	1.74	1.92	1.1	.005
A-7E	159,611	344.0	2.9	2.59	2.78	1.1	.008
AV-8A	19,396	1,212.3	0.8	0.88	0.91	1.0	.001
F-4J	115,070	439.2	2.3	0.82	0.97	1.2	.002
F-8J	18,317						
F-14A	51,286	596.3	1.7	0.93	1.01	1.1	.002
P-3C	125,860	485.9	2.1	2.44	3.95	1.6	.008
S-3A	60,552	284.3	3.5	1.23	2.13	1.7	.007

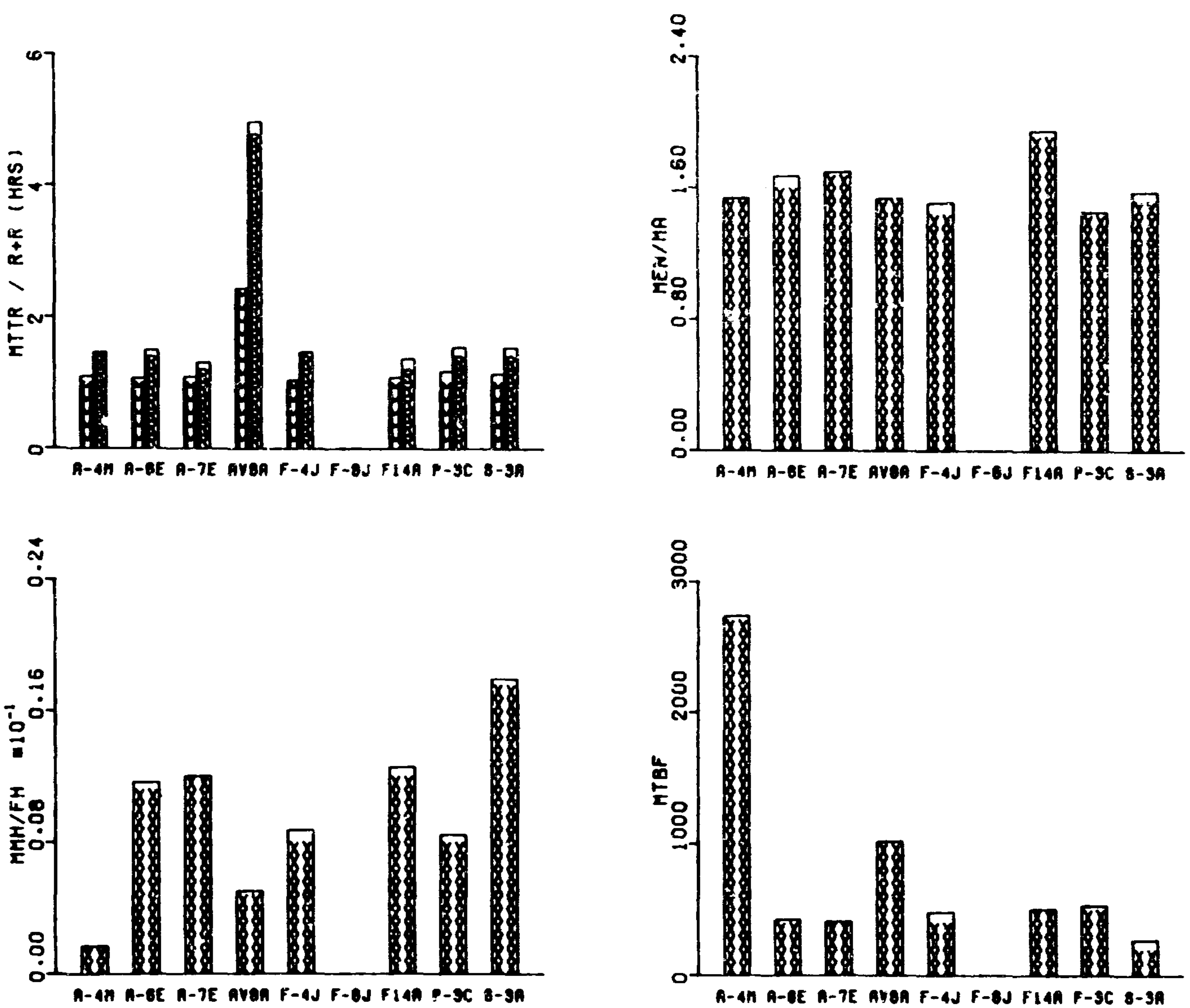


FIGURE 6.62 SELECTED GRAPHICAL DATA - RADAR ALTIMETER INDICATORS

6.13.4 Radar Altimeter Indicators (See preceding Table and Figure 6.62)

WORK UNIT CODES

A-4 72363	A-6 72362	A-7 72362	AV-8 722B2	F-4 72362
F-8 N/A	F-14 722B5	P-3 7236C	S-3 722H2	

DISCUSSION

Comments:

The only installation posing a significant problem in the area of R+R elapsed time is the AV-8A. Although the average time reflected here is based on 12 actions, it is considered valid. Fortunately, as in other cases of AV-8A equipment, the saving feature is a high MTBF. However, if the need to remove other aircraft instruments/hardware (Nav Control Panel, Central Warning Indicator, Glare Shield, Fuel Jettison Panel and the loosening of the right side of the instrument panel) could be avoided, a substantial improvement could be affected. This appears to be a common fault among the AV-8A cockpit installations.

Recommendations:

Eliminate need to remove other equipments/hardware to gain access or effect removal of unrelated equipment. Use of rack and panel connectors could do much to relieve the existing unsatisfactory situation.

Require that BIT/BITE provisions satisfy all requirements for after installation checks.

TABLE 6.63 MAINTENANCE DATA - DOPPLER/RADAR R/T UNITS

WORK UNIT CODES

A-4	72381	A-6	72381	A-7	73A31	AV-8	N/A	F-4	N/A
F-8	N/A	F-14	N/A	P-3	723A2	S-3	727H3		

ORGANIZATIONAL LEVEL

A/C	FLIGHT HOURS	MFHBMA	MA/FH X10-3	MTTR	MMH/MA	MEN/MA	MMH/FH	R+R	O+I MTBF
A-4M	35,571	1,616.9	0.6	1.94	4.04	2.1	.002	1.60	1,547
A-6E	87,564	32.3	30.9	1.39	2.32	1.7	.072	1.52	36
A-7E	159,611	40.3	24.8	1.42	2.74	1.9	.068	1.75	61
AV-8A	19,396								
F-4J	115,070								
F-8J	18,317								
F-14A	51,286								
P-3C	125,860	307.0	3.3	1.67	3.04	1.8	.010	2.01	520
S-3A	60,552	118.7	8.4	2.20	4.58	2.1	.039	3.37	170

INTERMEDIATE LEVEL

A/C	FLIGHT HOURS	MFHBMA	MA/FH X10-3	MTTR	MMH/MA	MEN/MA	MMH/FH
A-4M	35,571	1,368.1	0.7	9.49	9.90	1.0	.007
A-6E	87,564	34.6	28.9	4.22	5.54	1.3	.160
A-7E	159,611	52.2	19.2	3.32	4.96	1.5	.095
AV-8A	19,396						
F-4J	115,070						
F-8J	18,317						
F-14A	51,286						
P-3C	125,860	428.1	2.3	3.13	3.74	1.2	.009
S-3A	60,552	180.2	5.5	8.33	13.20	1.6	.073

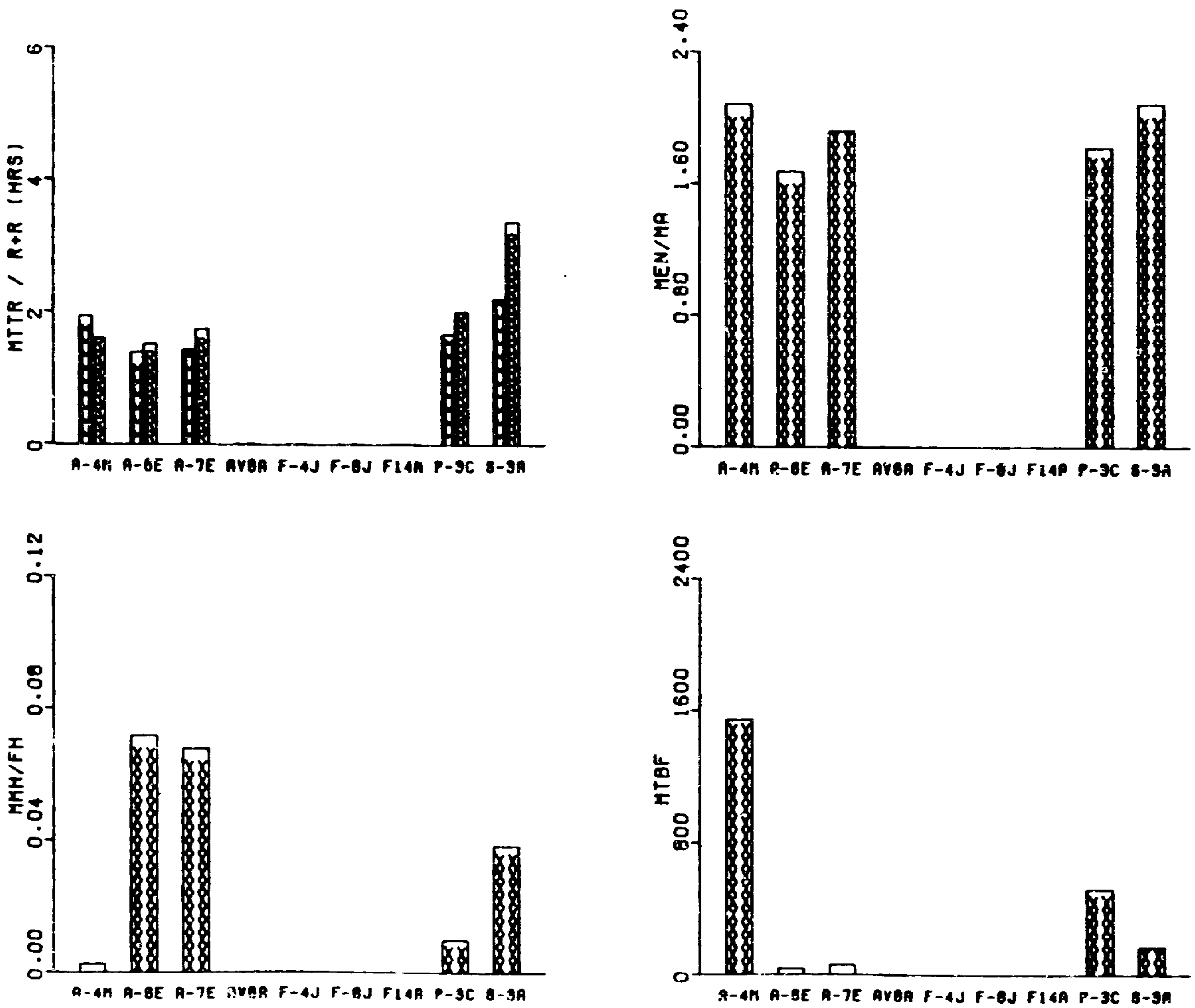


FIGURE 6.63 SELECTED GRAPHICAL DATA - DOPPLER/RADAR R/T UNITS

6.13.5 Doppler/Radar R/T Units (See preceding Table and Figure 6.63)

WORK UNIT CODES

A-4 72381	A-6 72381	A-7 73A31	AV-8 N/A	F-4 N/A
F-8 N/A	F-14 N/A	P-3 723A2	S-3 727H3	

DISCUSSION

Comments:

At first glance, the R+R elapsed time recorded for the S-3A appears to be out of line with the other installations. However, it must be noted that all installations are for Doppler RT units with the exception of the S-3A which is an APS-116 Search Radar Transmitter installation. The transmitter weighs 173 pounds and requires ten steps in the removal sequence. After installation checks require purging of the waveguide system, as well as a leak check and a full functional check with at least 200 foot clearance in front of the aircraft. When the Doppler radars are reviewed as a separate entity, only one installation falls outside an arbitrary 15% envelope about the mean. That installation is on the P-3C and it exceeds the envelope by only 5.4 minutes. All installations were considered good and only minor improvements could be made to any installation surveyed. It was apparent that serious attempts were made to optimize maintainability.

Recommendations:

Minimize the number of fasteners involved to gain access to equipment. This can be accomplished in one of the following ways: use hinged doors with quick release latches, use quick release fasteners rather than screws, or break large surface panels into several smaller ones held in place with quick release fasteners.

Specify that BIT/BITE provisions satisfy all requirements for after installation checks.

TABLE 6.64 MAINTENANCE DATA - DOPPLER/RADAR ANTENNAS

WORK UNIT CODES

A-4	72382	A-6	72451	A-7	73A32	AV-8	N/A	F-4	N/A
F-8	N/A	F-14	N/A	P-3	726A1	S-3	N/A		

ORGANIZATIONAL LEVEL

A/C	FLIGHT HOURS	MFHBMA	MA/FH X10-3	MTTR	MMH/MA	MEN/MA	MMH/FH	R+R	O+I MTBF
A-4M	35,571	17,785.5	0.1	1.65	2.65	1.6	.000	1.80	35,571
A-6E	87,564	4,864.7	0.2	3.47	6.94	2.0	.001	4.54	5,473
A-7E	159,611	384.6	2.6	2.90	6.04	2.1	.016	3.53	798
AV-8A	19,396								
F-4J	115,070								
F-8J	18,317								
F-14A	51,286								
P-3C	125,860	150.9	6.6	2.20	4.33	2.0	.029	3.53	207
S-3A	60,552								

INTERMEDIATE LEVEL

A/C	FLIGHT HOURS	MFHBMA	MA/FH X10-3	MTTR	MMH/MA	MEN/MA	MMH/FH
A-4M	35,571	35,571.0	0.0	5.00	5.00	1.0	.000
A-6E	87,564	4,608.6	0.2	6.08	8.53	1.4	.002
A-7E	159,611	589.0	1.7	3.12	4.79	1.5	.008
AV-8A	19,396						
F-4J	115,070						
F-8J	18,317						
F-14A	51,286						
P-3C	125,860	772.1	1.3	4.78	8.73	1.8	.011
S-3A	60,552						

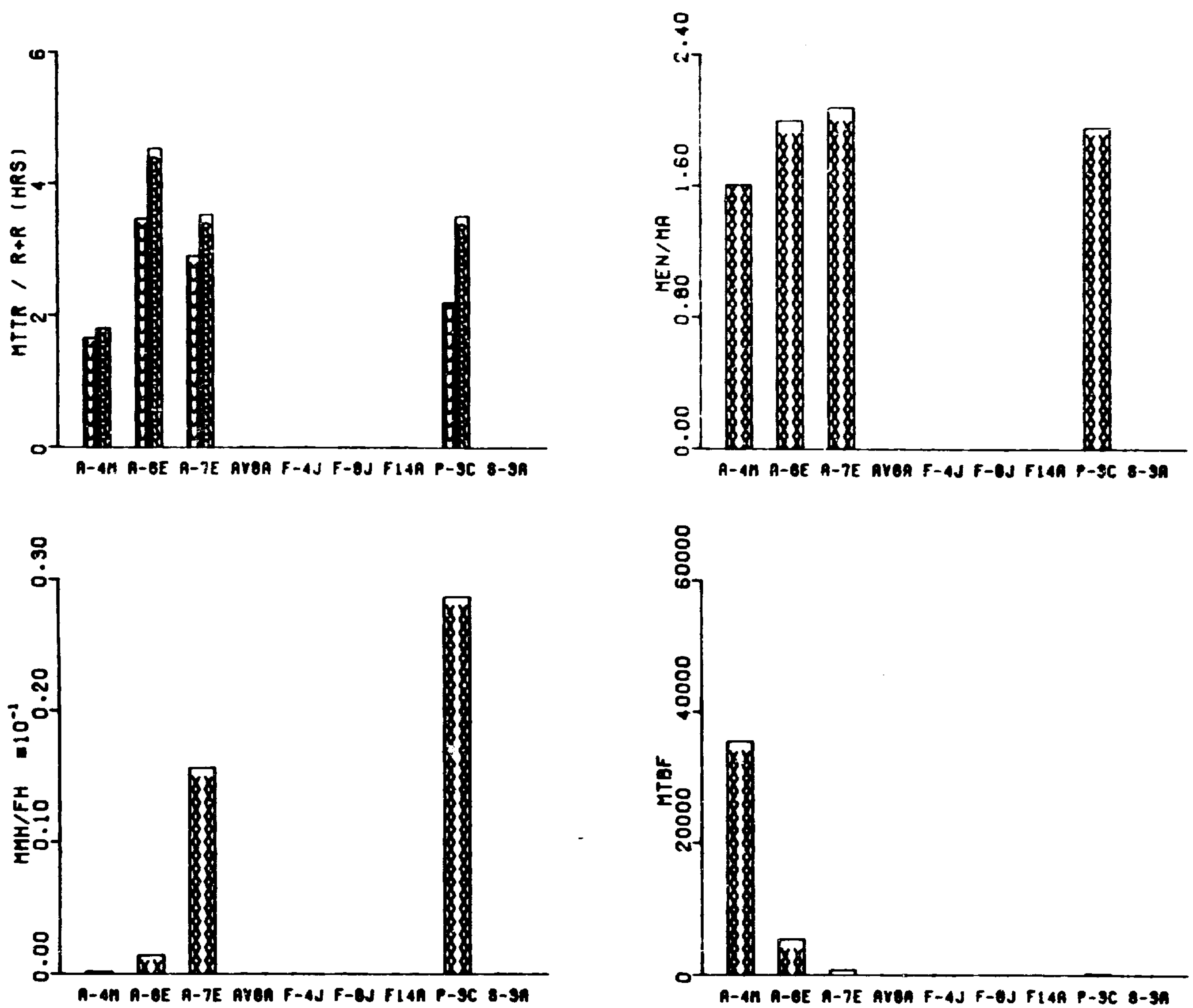


FIGURE 6.64 SELECTED GRAPHICAL DATA - DOPPLER/RADAR ANTENNAS

6.13.6 Doppler/Radar Antennas (See preceding Table and Figure 6.64)

WORK UNIT CODES

A-4 72382	A-6 72451	A-7 73A32	AV-8 N/A	F-4 N/A
F-8 N/A	F-14 N/A	P-3 726A1	S-3 N/A	

DISCUSSION

Comments:

The qualitative analysis of these installations were critical of all but one, the P-3C. There because of its size, the installation was considered good despite the number of steps and actions involved in the removal procedure. Of the remaining three installations, the R+R data for the A-4M is considered invalid due to the number of occurrences involved (1) and the sample size for the A-6E (12) is questionable. Removal of the antenna on the A-4M requires the removal of 40 screws which secure the radome and, during installation, the antenna must be manually aligned and held in place while the mounting bolts are inserted. All actions take place on a maintenance stand which contributes to making this a tedious and tiresome task. The latter holds true for the A-6E also. The tasks could be greatly simplified through the use of a handling fixture/hoist to relieve the technicians of the weight of the unit as they concentrate on alignment and mounting. The A-7E antenna installation causes problems for the technician because of the number of screws involved (65) and the location of the unit in close proximity to the deck.

Recommendations:

Require that Installation Designers place additional emphasis on the human factors involved in a removal and replacement task.

Minimize the number of fasteners involved in gaining access to equipment. This can be affected by utilizing one or more of the following techniques: use hinged doors with quick release latches, use quick release fasteners rather than screws, or break large unwieldy panels into several smaller ones secured with quick release fasteners.

TABLE 6.65 MAINTENANCE DATA - RADAR CONTROL BOXES

WORK UNIT CODES

A-4	72384	A-6	N/A	A-7	73A33	AV-8	N/A	F-4	N/A
F-8	N/A	F-14	N/A	P-3	N/A	S-3	729F2		

ORGANIZATIONAL LEVEL

A/C	FLIGHT HOURS	MFHBMA	MA/FH X10-3	MTTR	MMH/MA	MEN/MA	MMH/FH	R+R	O+I MTBF
A-4M	35,571	7,114.2	0.1	1.30	2.60	2.0	.000	1.30	8,893
A-6E	87,564								
A-7E	159,611	154.5	6.5	1.30	2.42	1.9	.016	1.65	296
AV-8A	19,396								
F-4J	115,070								
F-8J	18,317								
F-14A	51,286								
P-3C	125,860								
S-3A	60,552	96.9	10.3	1.41	2.46	1.7	.025	2.31	175

INTERMEDIATE LEVEL

A/C	FLIGHT HOURS	MFHBMA	MA/FH X10-3	MTTR	MMH/MA	MEN/MA	MMH/FH
A-4M	35,571	7,114.2	0.1	6.20	7.20	1.2	.001
A-6E	87,564						
A-7E	159,611	256.2	3.9	2.48	3.42	1.4	.013
AV-8A	19,396						
F-4J	115,070						
F-8J	18,317						
F-14A	51,286						
P-3C	125,860						
S-3A	60,552	171.1	5.8	4.33	7.49	1.7	.044

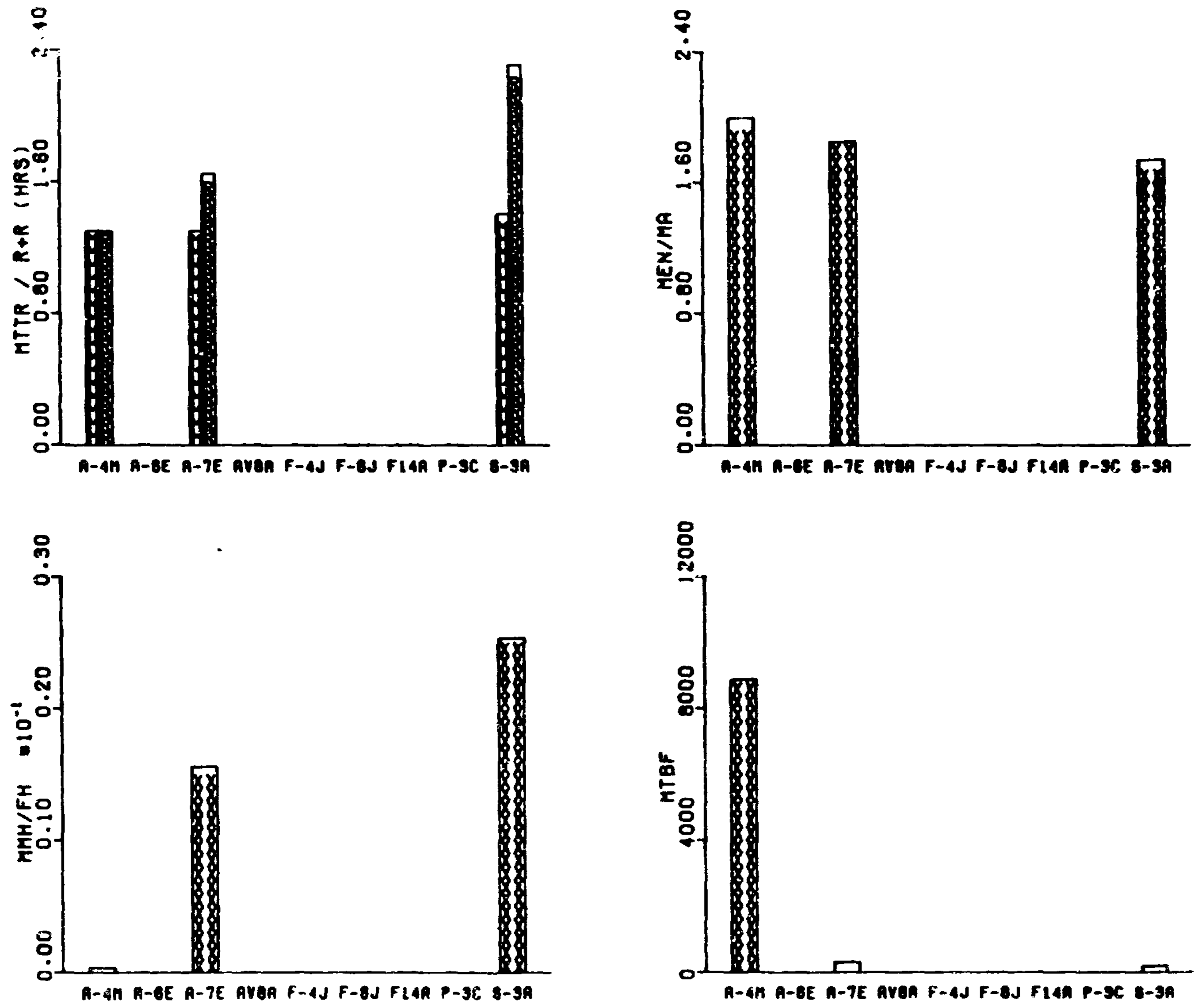


FIGURE 6.65 SELECTED GRAPHICAL DATA - RADAR CONTROL BOXES

6.14 BOMB NAVIGATION AND WEAPONS CONTROL SYSTEMS

6.14.1 Radar Control Boxes (See preceding Table and Figure 6.65)

WORK UNIT CODES

A-4 72384	A-6 N/A	A-7 73A33	AV-8 N/A	F-4 N/A
F-8 N/A	F-14 N/A	P-3 N/A	S-3 723F2	

DISCUSSION

Comments:

The R+R data size for the A-4M only encompasses five actions, but the qualitative analysis indicates that the time reflected here is probably indicative of the average that would be obtained from a larger sample. All installations are good. They can be characterized as having a minimum of connectors and mounting fasteners and all have BIT or self-test provisions. The additional time required for the S-3A is due to the time needed to accomplish a radar operational or diagnostic program and the need to move the aircraft to a remote location prior to radiating. The latter requirements are a result of the complexity of the Control Set.

Recommendations:

Require use of an external RF absorbtion blanket to decrease the radiation hazard and reduce the requirement for moving the aircraft prior to radiating.

Specify that BIT/BITE provisions satisfy all requirements of after installation checks. This need increases in importance as the complexity of the equipment increases.

TABLE 6.66 MAINTENANCE DATA - RADAR ANTENNAS

WORK UNIT CODES

A-4	N/A	A-6	7434E	A-7	73A11	AV-8	N/A	F-4	74241
74251	F-8	N/A	F-14	N/A	P-3	N/A	S-3	N/A	

ORGANIZATIONAL LEVEL

A/C	FLIGHT HOURS	MFHBMA	MA/FH X10-3	MTTR	MMH/MA	MEN/MA	MMH/FH	R+R	O+I MTBF
A-4M	35,571								
A-6E	87,564								
A-7E	159,611	86.2	11.6	2.15	4.42	2.1	.051	2.86	97
AV-8A	19,396								
F-4J	115,070	2,054.8	0.5	2.38	4.89	2.1	.002	2.25	2,448
F-8J	18,317								
F-14A	51,286								
P-3C	125,860								
S-3A	60,552								
INTERMEDIATE LEVEL									
A-4M	35,571								
A-6E	87,564	87,564.0	0.0	1.00	1.00	1.0	.000		
A-7E	159,611	114.3	8.8	5.84	8.43	1.4	.074		
AV-8A	19,396								
F-4J	115,070	2,171.1	0.5	6.80	10.74	1.6	.005		
F-8J	18,317								
F-14A	51,286								
P-3C	125,860								
S-3A	60,552								

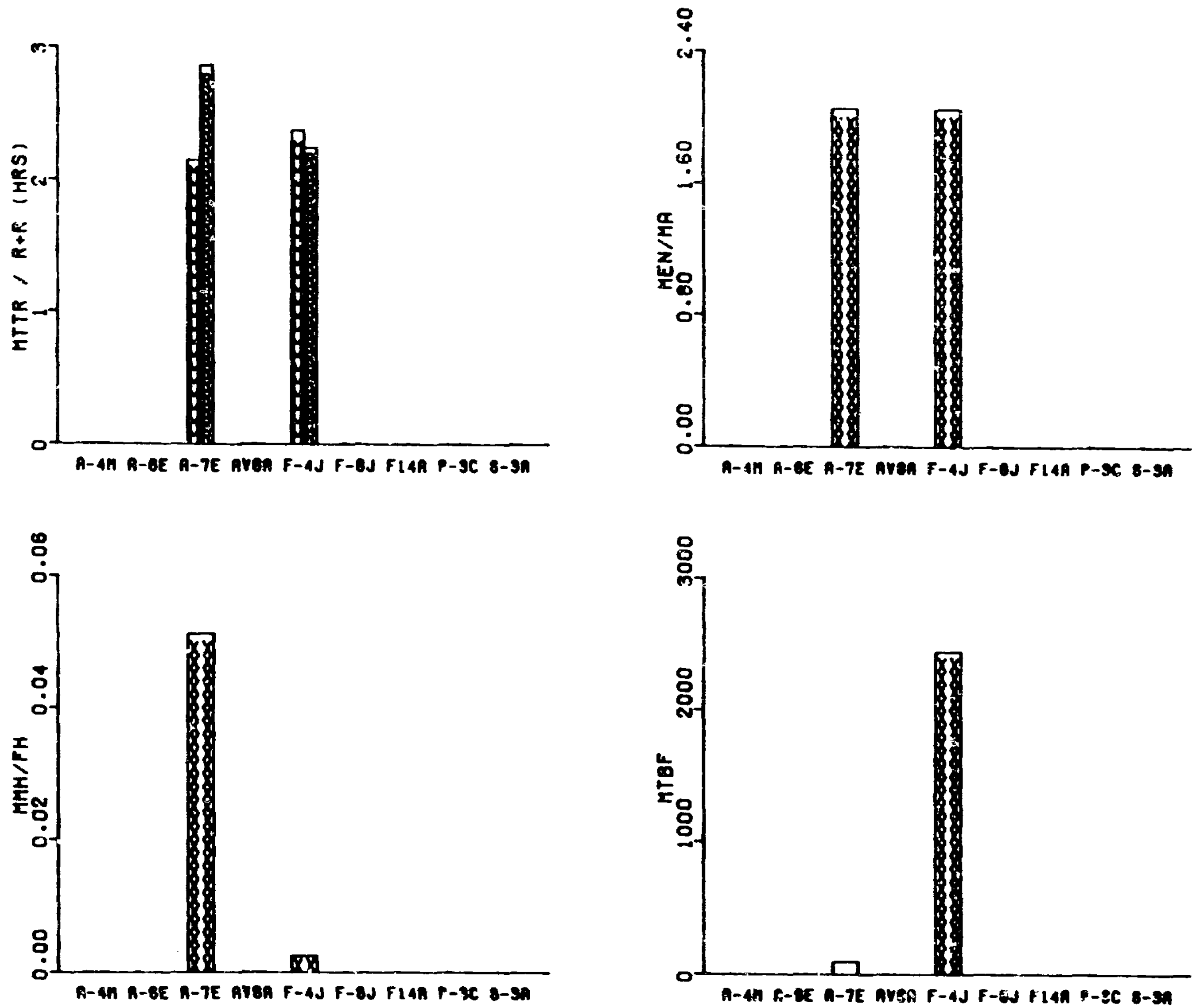


FIGURE 6.66 SELECTED GRAPHICAL DATA - RADAR ANTENNAS

[illegible] Radar Antennas (See preceding Table and Figure 6.66)

WORK UNIT CODES

A-4 N/A	A-6 7434E	A-7 73A11	AV-8 N/A	F-4 74241, 74251
F-8 N/A	F-14 N/A	P-3 N/A	S-3 N/A	

DISCUSSION

Comments:

The measurable R+R task values are quantitatively comparable and parallel to the comments contained in the qualitative analysis. Both the A-7E and F-4J installations were considered good because of accessibility to connectors, lines and mounting bolts, provisions for BIT or self test, and the convenience of gaining access. The 25 minute difference in the R+R time is primarily due to the need for an operational check on the A-7E radar following accomplishment of the self-test. No data was received for the A-6E through either the ECIP or ECA programs. However, the qualitative evaluation of the installation is critical of the need to insert the mounting bolts from the wheel well area and of the lack of BIT.

Recommendations:

Establish BIT/BITE requirements on all designs and specify that they be comprehensive enough to eliminate the needs for follow-on operational checks.

Eliminate the need to obtain access to other compartments or areas to accomplish the physical act of removal and installation.

TABLE 6.67 MAINTENANCE DATA - POWER SUPPLIES

WORK UNIT CODES

A-4	N/A	A-6	7434H	A-7	73A13	AV-8	N/A	F-4	7424A
7424L	7424N	74245	74257	F-8	74453	F-14	74A61	P-3	N/A
S-3	N/A								

ORGANIZATIONAL LEVEL

A/C	FLIGHT HOURS	MFHBMA	MA/FH X10-3	MTTR	MMH/MA	MEN/MA	MMH/FH	R+R	O+I MTBF
A-4M	35,571								
A-6E	87,564								
A-7E	159,611	125.6	8.0	2.14	4.32	2.0	.034	2.65	130
AV-8A	19,396								
F-4J	115,070	485.5	2.1	1.48	3.12	2.1	.006	1.63	559
F-8J	18,317	254.4	3.9	2.38	4.65	2.0	.018	3.27	346
F-14A	51,286	253.9	3.9	1.32	3.08	2.3	.012	2.21	435
P-3C	125,860								
S-3A	60,552								

INTERMEDIATE LEVEL

A/C	FLIGHT HOURS	MFHBMA	MA/FH X10-3	MTTR	MMH/MA	MEN/MA	MMH/FH
A-4M	35,571						
A-6E	87,564						
A-7E	159,611	123.2	8.1	4.62	6.46	1.4	.052
AV-8A	19,396						
F-4J	115,070	413.9	2.4	3.43	4.75	1.4	.011
F-8J	18,317	469.7	2.1	0.84	1.02	1.2	.002
F-14A	51,286	326.7	3.1	5.31	7.66	1.4	.023
P-3C	125,860						
S-3A	60,552						

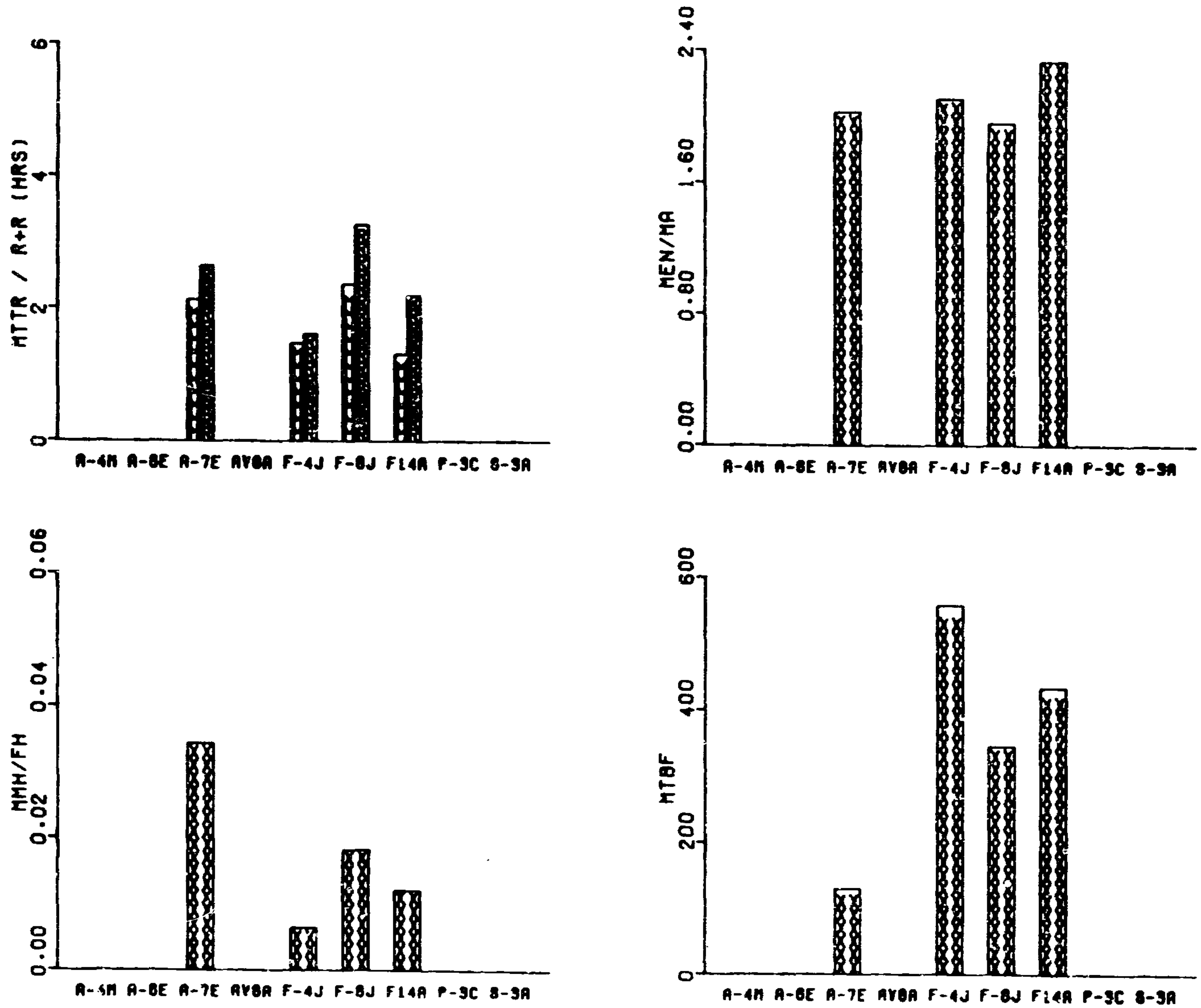


FIGURE 6.67 SELECTED GRAPHICAL DATA - POWER SUPPLIES

6.14.3 Power Supplies (See preceding Table and Figure 6.67)

WORK UNIT CODES

A-4 N/A	A-6 7434H	A-7 73A13	AV-8 N/A	F-4 7424A, 7424_, 7424N, 742-_, 74257
F-8 744__	F-14 74A61	P-3 N/A	S-3 N/A	

DISCUSSION

Comments:

The ASMRA 3CIP and ECA data tapes did not contain information for the A-6E. Consequently the quantitative data reflects zeroes for the 18 month period involved. The high R+R time for the F-4J is readily explainable through the qualitative analysis which documents the need to disconnect the canopy and remove the seat in order to accomplish what should be a simple remove and replace action. The saving grace on the F-4J installation must be the BIT check which eliminates the need for an operational/functional check, since on the surface, the access tasks are time consuming. (Forty-nine stress panel fasteners and a need for a work stand.)

Recommendations:

Whenever possible, eliminate the need for a workstand.

Require full BIT on all new design/procurement. BIT should be comprehensive enough to eliminate the need for operational/functional check.

Prohibit the removal of unrelated equipments/hardware to accomplish an R+R action.

Use quick release fasteners or latches on hinged doors rather than stress fasteners on panels to ease initial access to equipment.

TABLE 6.68 MAINTENANCE DATA - TRANSMITTERS

WORK UNIT CODES

A-4	N/A	A-6	74348	A-7	73A12	AV-8	N/A	F-4	N/A
F-8	N/A	F-14	74A15	P-3	N/A	S-3	N/A		

ORGANIZATIONAL LEVEL

A/C	FLIGHT HOURS	MFHBMA	MA/FH X10-3	MTTR	MMH/MA	MEN/MA	MMH/FH	R+R	O+I MTBF
A-4M	35,571								
A-6E	87,564	29,188.0	0.0	7.17	12.17	1.7	.000	2.00	87,564
A-7E	139,611	163.4	6.1	2.26	4.58	2.0	.028	2.75	174
AV-8A	19,396								
F-4J	115,070								
F-8J	18,317								
F-14A	51,286	35.3	28.3	2.17	6.08	2.8	.172	3.26	48
P-3C	125,860								
S-3A	60,552								

INTERMEDIATE LEVEL

A/C	FLIGHT HOURS	MFHBMA	MA/FH X10-3	MTTR	MMH/MA	MEN/MA	MMH/FH
A-4M	35,571						
A-6E	87,564	43,782.0	0.0	4.50	4.50	1.0	.000
A-7E	159,611	161.5	6.2	5.22	7.63	1.5	.047
AV-8A	19,396						
F-4J	115,070						
F-8J	18,317						
F-14A	51,286	41.1	24.3	5.22	7.51	1.4	.183
P-3C	125,860						
S-3A	60,552						

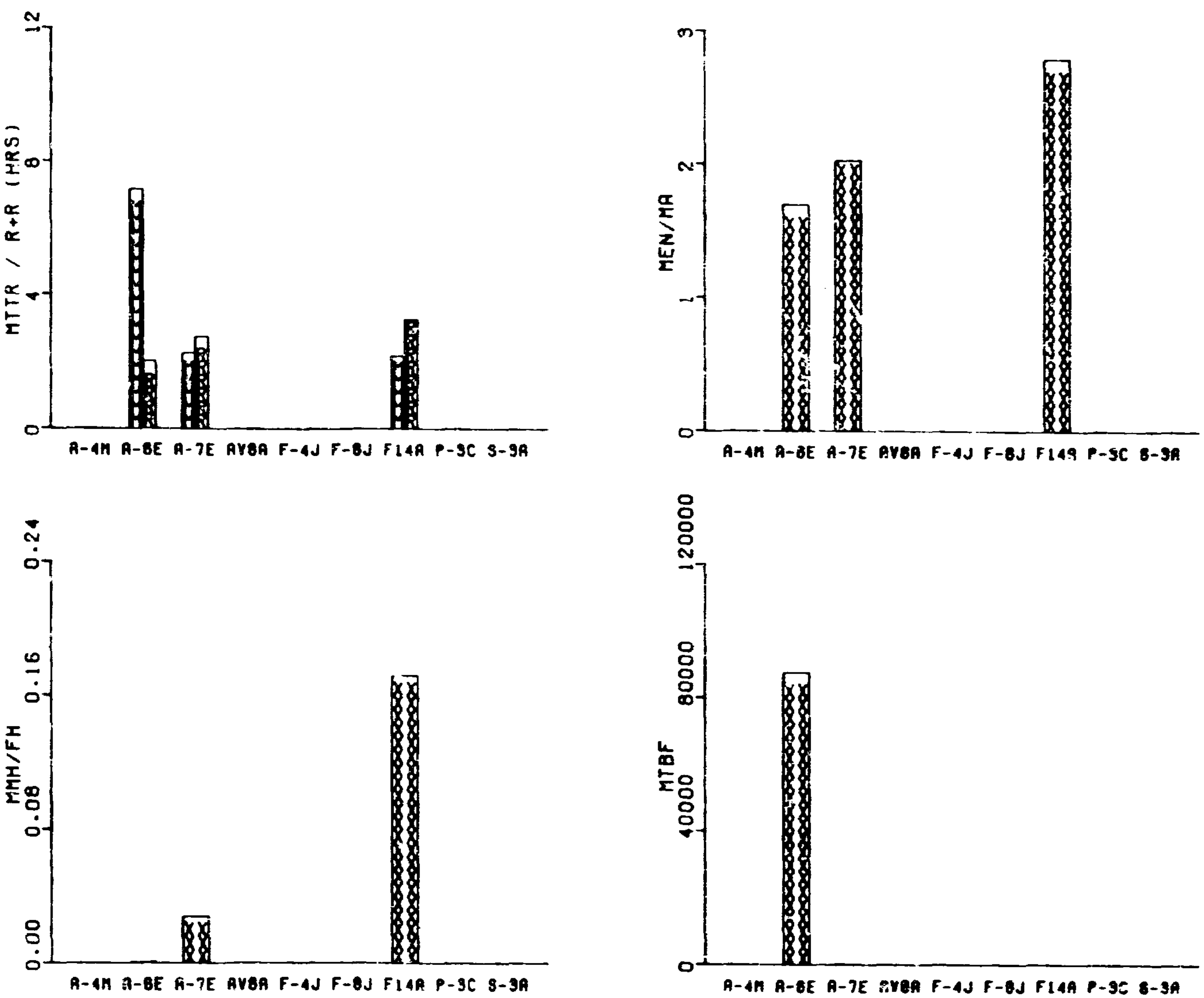


FIGURE 6.68 SELECTED GRAPHICAL DATA - TRANSMITTERS

6.[illegible] Transmitters (See preceding Table and Figure 6.68)

WORK UNIT CODES

A-4 N/A	A-6 74348	A-7 73A12	AV-8 N/A	F-4 N/A
F-8 N/A	F-14 74A15	P-3 N/A	S-3 N/A	

DISCUSSION

Comments:

The data for the A-6E is based on two actions in the category of R+R and three actions in all other areas. As a result, although the qualitative analysis rates the A-6E as a "good" installation, the data presented here is considered not statistically valid. The A-7E and F-14A installations are considered acceptable and the approximately 30 minutes difference in R+R time is attributed to the weight of the transmitter (180 pounds). This is also reflected in the MEN/MA column which reveals the average number of technicians used to accomplish a task on this installation approximates three.

Recommendations:

Reevaluate the need to design WRA's whose weight cannot be accommodated by one man. If the design cannot be avoided, ensure the unit is installed at ground level and avoid the use of work stands. Additionally provide mechanical/electrical means to aid the technician in the removal/replacement action.

TABLE 6.69 MAINTENANCE DATA - INDICATORS

WORK UNIT CODES

A-4	N/A	A-6	72X1E	724EC	A-7	73A15	AV-8	N/A	F-4
74248	7424C	74258	F-8	74456	F-14	74A53	P-3	732A1	S-3
73843									

ORGANIZATIONAL LEVEL

A/C	FLIGHT HOURS	MFHBMA	MA/FH X10-3	MTTR	MMH/MA	MEN/MA	MMH/FH	R+R	O+I MTBF
A-4M	35,571								
A-6E	87,564	116.9	8.6	1.54	3.04	2.0	.026	1.88	182
A-7E	159,611	63.5	15.7	1.67	3.32	2.0	.052	2.13	96
AV-8A	19,396								
F-4J	115,070	561.3	1.8	1.62	3.31	2.0	.006	1.72	622
F-8J	18,317	38.3	26.1	1.95	3.75	1.9	.098	2.86	61
F-14A	51,286	47.6	21.0	1.29	3.03	2.4	.064	2.07	79
P-3C	125,860	134.8	7.4	1.41	2.20	1.6	.016	1.95	258
S-3A	60,552	30.8	32.4	1.51	2.93	1.9	.095	2.37	74

INTERMEDIATE LEVEL

A/C	FLIGHT HOURS	MFHBMA	MA/FH X10-3	MTTR	MMH/MA	MEN/MA	MMH/FH
A-4M	35,571						
A-6E	87,564	162.2	6.2	4.36	7.18	1.6	.044
A-7E	159,611	99.8	10.0	4.58	6.67	1.5	.067
AV-8A	19,396						
F-4J	115,070	852.4	1.2	4.54	6.07	1.3	.007
F-8J	18,317	71.0	14.1	3.32	4.77	1.4	.067
F-14A	51,286	80.8	12.4	5.32	7.38	1.4	.091
P-3C	125,860	345.8	2.9	5.00	6.66	1.3	.019
S-3A	60,552	71.6	14.0	3.97	5.35	1.3	.075

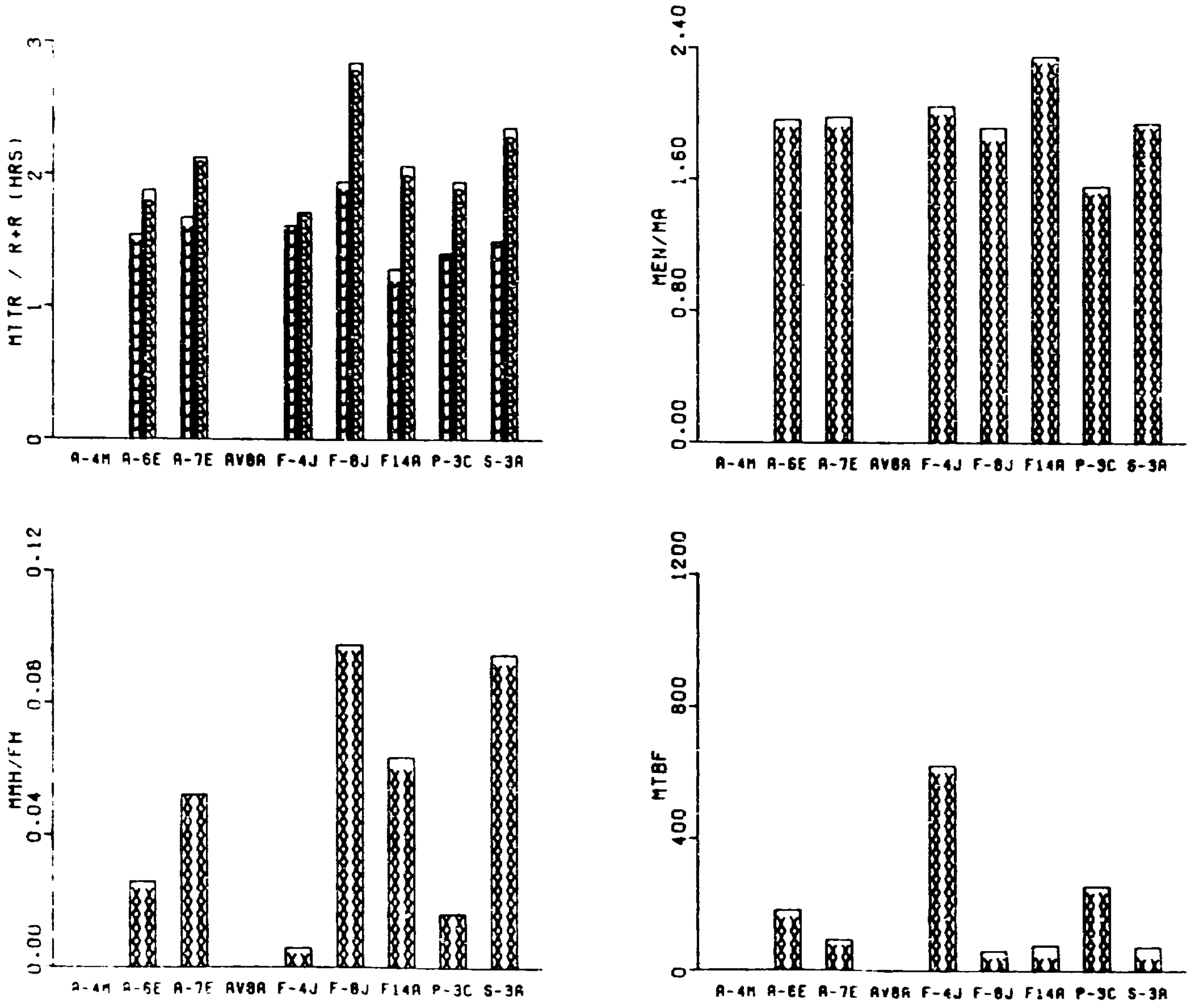


FIGURE 6.69 SELECTED GRAPHICAL DATA - INDICATORS

6.14.5 Indicators (See preceding Table and Figure 6.69)

WORK UNIT CODES

A-4 N/A	A-6 724EC, 72X1E	A-7 73A15	AV-8 N/A	F-[illegible] 742-E, 7424C, 7425B
F-8 74456	F-14 74A53	P-3 732A1	S-3 73B43	

DISCUSSION

Comments:

In the two installations with the highest R+R time, access panel removal is required (F-8J and S-3A). In the case of the S-3A, the unit is large and bulky while in the F-8, the indicator is mounted in the instrument panel. When limits are established at ±15% of the mean for R+R, the only installation exceeding the limit is the F-8J. This is due primarily to frequent repair of the main electrical connector which has shortened cable length to the point that technicians must mate the connector in the blind and to the after installation operational check requirement.

Recommendations:

Specify rack and panel connectors with latch type locking mechanisms to align and jack unit into connector and secure it to the panel.

Prohibit removal of adjacent equipments/hardware, even if referred to as access panels, in all instrument panel installations.

Ensure that cable length is sufficient to allow for a specified number of repairs/splices and still permit removal of the unit a sufficient distance to allow disconnect if, rack and panel connectors are not used.

TABLE 6.70 MAINTENANCE DATA - CONTROLS, RADAR SET

WORK UNIT CODES

A-4	N/A	A-6	72Y1R	A-7	73A10	AV-8	739W6	F-4	7424E
7425E	F-8	N/A	F-14	74A51	P-3	N/A	S-3	N/A	

ORGANIZATIONAL LEVEL

A/C	FLIGHT HOURS	MFHBMA	MA/FH X10-3	MTTR	MMH/MA	MEN/MA	MMH/FH	R+R	O+I MTBF
A-4M	35,571								
A-6E	87,564	8,756.4	0.1	1.76	3.17	1.8	.000	1.17	21,891
A-7E	159,611	514.9	1.9	1.24	2.34	1.9	.005	1.65	950
AV-8A	19,396	174.7	5.7	1.96	3.50	1.8	.020	2.39	524
F-4J	115,070	6,768.8	0.1	0.99	1.84	1.9	.000	1.47	14,384
F-8J	18,317								
F-14A	51,286	208.5	4.8	1.03	2.07	2.0	.010	1.77	438
P-3C	125,860								
S-3A	60,552								

INTERMEDIATE LEVEL

A/C	FLIGHT HOURS	MFHBMA	MA/FH X10-3	MTTR	MMH/MA	MEN/MA	MMH/FH
A-4M	35,571						
A-6E	87,564	29,188.0	0.0	5.33	6.00	1.1	.000
A-7E	159,611	1,071.2	0.9	3.70	5.03	1.4	.005
AV-8A	19,396	307.9	3.2	5.80	7.79	1.3	.025
F-4J	115,070	8,851.5	0.1	6.28	8.55	1.4	.001
F-8J	18,317						
F-14A	51,286	479.3	2.1	2.59	3.78	1.5	.008
P-3C	125,860						
S-3A	60,552						

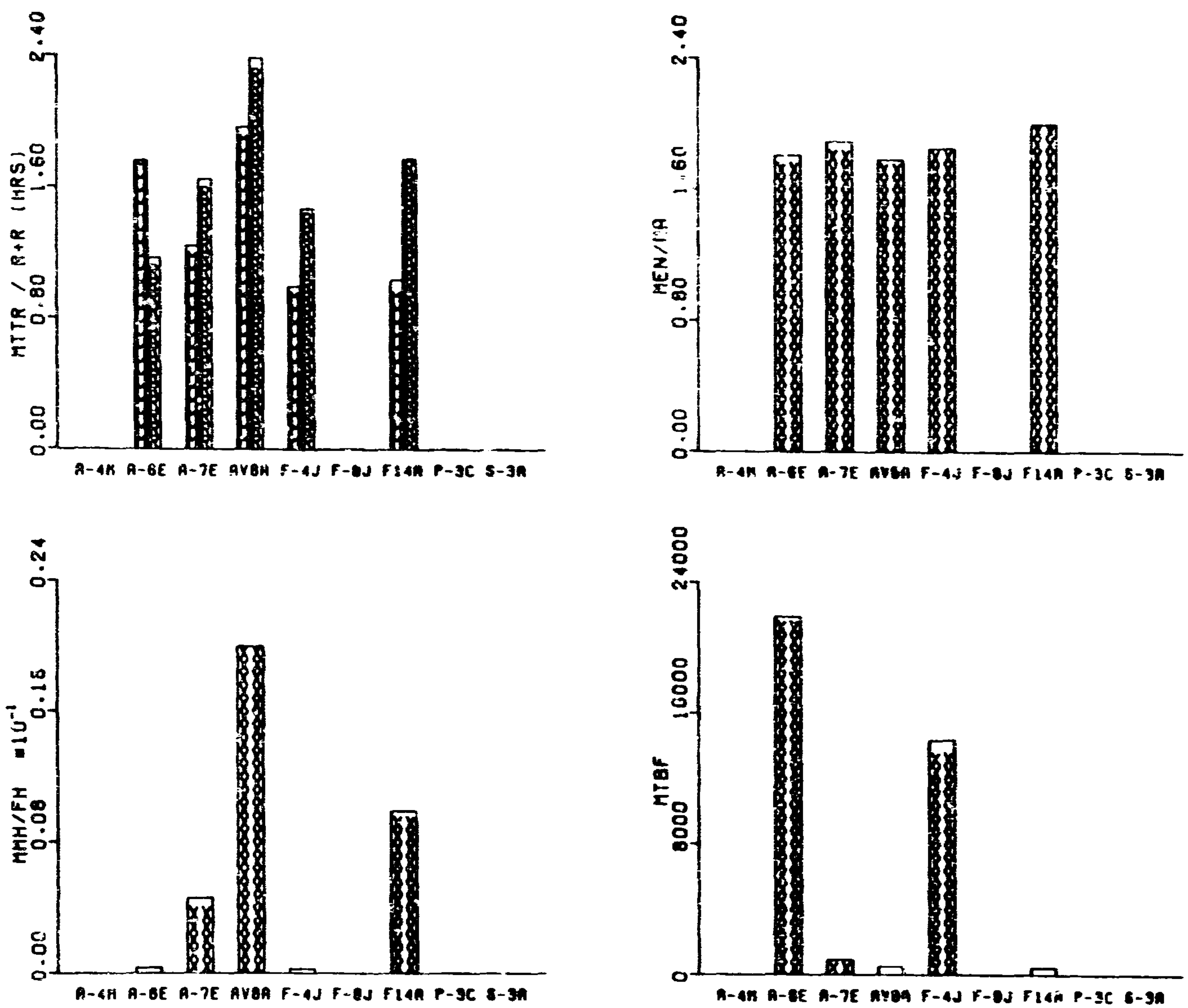


FIGURE 6.70 SELECTED GRAPHICAL DATA - CONTROLS, RADAR SET

6.14.6 Controls, Radar Set (See preceding Table and Figure 6.70)

WORK UNIT CODES

A-4 N/A	A-6 72Y1R	A-7 73A1D	AV-8 739W6	F-4 7424E, 7425E
F-8 N/A	F-14 74A51	P-3 N/A	S-3 N/A	

DISCUSSION

Comments:

Once again, the sample size of the A-6E data dictates that it be considered invalid. The R+R average is based on only three actions and the remaining columnar entries were formulated on ten maintenance actions reported for the 18 month period involved. The one installation that appears out of line, quantitatively, is the AV-8A. The data is misleading in that the installation, qualitatively, is a good one. The cause for the high R+R time is a requirement to accomplish a "normal alignment of the IMS" during the after installation check. This adds approximately 40 minutes to the task. One other installation requires comment. The A-6E Radar Set Control is so large that the technician must straddle the center console to achieve removal. This presents a hazard to the technician and the danger of damage to equipment.

Recommendations:

Develop standards specifying weight and size limits for components that are mounted on, or in, the instrument panel.

Require that BIT/BITE provisions be included in all component/system design and that they be comprehensive enough to eliminate the need for operational/functional or integrated systems checks.

TABLE 6.71 MAINTENANCE DATA - SWEEP GENS/PROCESSORS/DATA CONVERTERS

WORK UNIT CODES

A-4	N/A	A-6	72457	A-7	73A16	AV-8	N/A	F-4	N/A
F-8	N/A	F-14	N/A	P-3	73X1N	S-3	73B31	734M2	

ORGANIZATIONAL LEVEL

A/C	FLIGHT HOURS	MFHBMA	MA/FH X10-3	MTTR	MMH/MA	MEN/MA	MMH/FH	R+R	O+I MTBF
A-4M	35,571								
A-6E	87,564	146.9	6.8	1.76	3.53	2.0	.024	2.07	123
A-7E	159,611	105.1	9.5	2.13	4.21	2.0	.040	2.59	126
AV-8A	19,396								
F-4J	115,070								
F-8J	18,317								
F-14A	51,286								
P-3C	125,860	47.9	20.9	2.00	3.00	1.5	.063	2.43	95
S-3A	60,552	33.8	29.6	1.37	2.23	1.6	.066	2.22	61

INTERMEDIATE LEVEL

A/C	FLIGHT HOURS	MFHBMA	MA/FH X10-3	MTTR	MMH/MA	MEN/MA	MMH/FH
A-4M	35,571						
A-6E	87,564	110.3	9.1	4.55	7.32	1.6	.066
A-7E	159,611	124.5	8.0	4.54	6.18	1.4	.050
AV-8A	19,396						
F-4J	115,070						
F-8J	18,317						
F-14A	51,286						
P-3C	125,860	102.8	9.7	1.18	1.33	1.1	.013
S-3A	60,552	51.4	19.4	3.69	6.17	1.7	.120

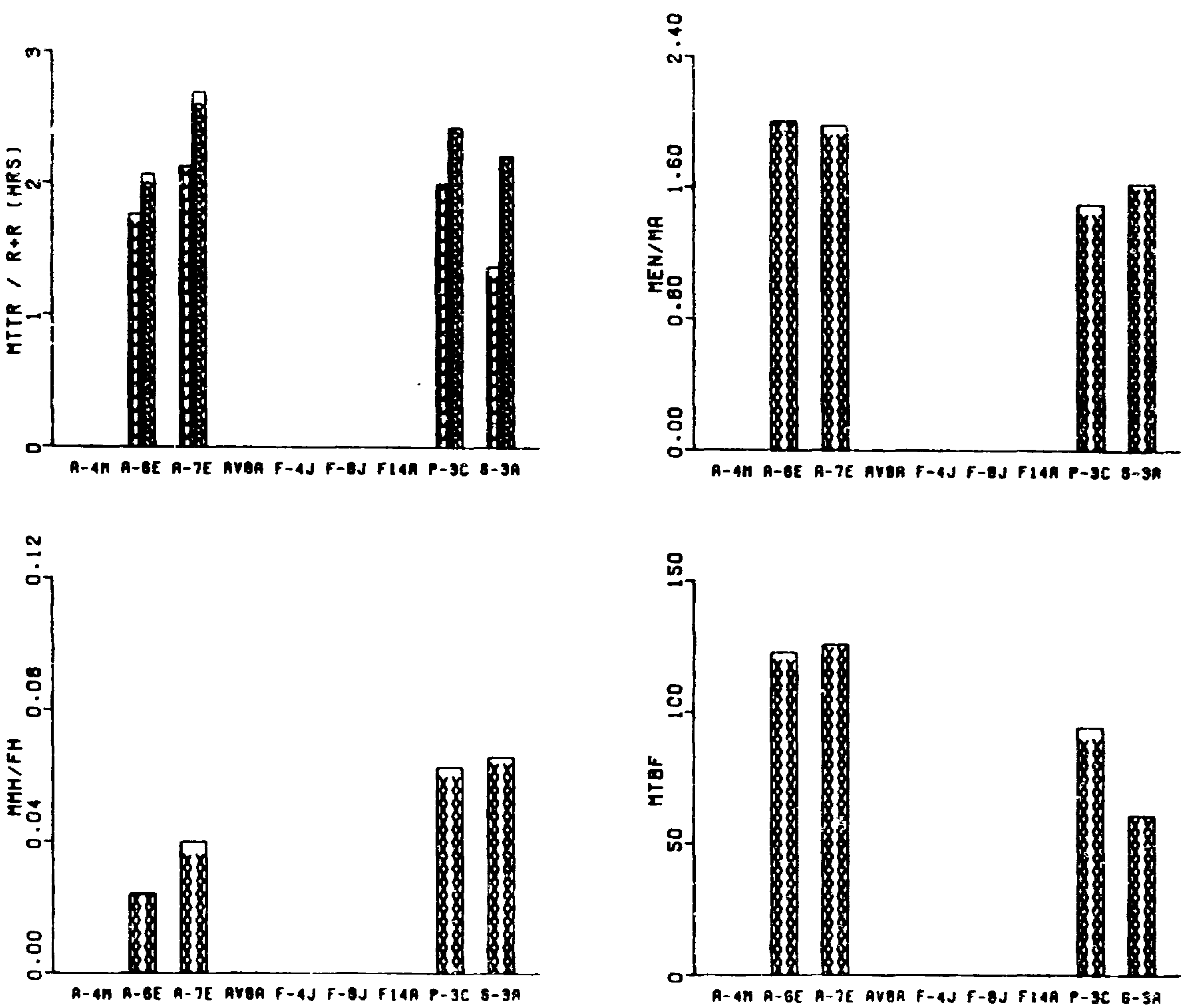


FIGURE 6.71 SELECTED GRAPHICAL DATA - SWEEP GENS/PROCESSORS/DATA CONVERTERS

6.14.7 Sweep Generators/Processors/Data Converters (See preceding Table and Figure 6.71)

WORK UNIT CODES

A-4 N/A	A-6 72457	A-7 73A16	AV-8 N/A	F-4 N/A
F-8 N/A	F-14 N/A	P-3 73X1M	S-3 73B31, 73482	

DISCUSSION

Comments:

Quantitatively, all installations fall within 15% of the mean R+R time. In spite of this, two installations, the A-7E and the P-3C, were considered qualitatively inadequate. The A-7E installation suffered due to the need for a workstand and the 21 fasteners in the access panel. The P-3C locates the Signal Data Converter in the corner of one of the numerous avionics racks. The P-3C installation is considered poor by comparison with the other installations on the same aircraft and considering the vast space availability aboard the aircraft. The best installation, from a maintainability point of view, is on the S-3A. To remove this unit merely requires loosening two quipment lock lugs (rack and panel connectors are utilized) and sliding the component from the mounting rack. The installation is the reverse of removal. However, the after installation check is long (1.5 to 2 hours) and tedious, adding significantly to the total R+R time and negating the advantages of a near perfect installation. The A-6E utilizes an equipment rack that can be lowered to ground level - an excellent feature - to avoid the use of workstands.

Recommendations:

Require that BIT/BITE provisions be included in all component/system design and, that they be comprehensive enough to eliminate, to the maximum extent possible, the need for follow-on operational/functional checks.

Utilize rack and panel connectors wherever and whenever possible. Encourage further development of the rack and panel mounting concept.

Employ equipment lock lug holddowns similar to those used on the S-3A, or use a latching type device to secure equipment.

Eliminate the need for workstands by requiring that equipment installed above shoulder height be mounted in racks that can be lowered to a convenient working level.

TABLE 6.72 MAINTENANCE DATA - TACTICAL/DIGITAL COMPUTERS

WORK UNIT CODES

A-4	N/A	A-6	N/A	A-7	73A21	AV-8	N/A	F-4	N/A
F-8	N/A	F-14	74A46	P-3	N/A	S-3	N/A		

ORGANIZATIONAL LEVEL

A/C	FLIGHT HOURS	MFHBMA	MA/FH X10-3	MTTR	MMH/MA	MEN/MA	MMH/FH	R+R	O+I MTBF
A-4M	35,571								
A-6E	87,564								
A-7E	159,611	49.1	20.4	1.81	3.74	2.1	.076	2.41	105
AV-8A	19,396								
F-4J	115,070								
F-8J	18,317								
F-14A	51,286	193.5	5.2	1.09	2.39	2.2	.012	1.59	765
P-3C	125,860								
S-3A	60,552								

INTERMEDIATE LEVEL

A/C	FLIGHT HOURS	MFHBMA	MA/FH X10-3	MTTR	MMH/MA	MEN/MA	MMH/FH	R+R	O+I MTBF
A-4M	35,571								
A-6E	87,564								
A-7E	159,611	90.1	11.1	3.96	8.49	2.1	.094		
AV-8A	19,396								
F-4J	115,070								
F-8J	18,317								
F-14A	51,286	377.1	2.7	3.78	5.04	1.3	.013		
P-3C	125,860								
S-3A	60,552								

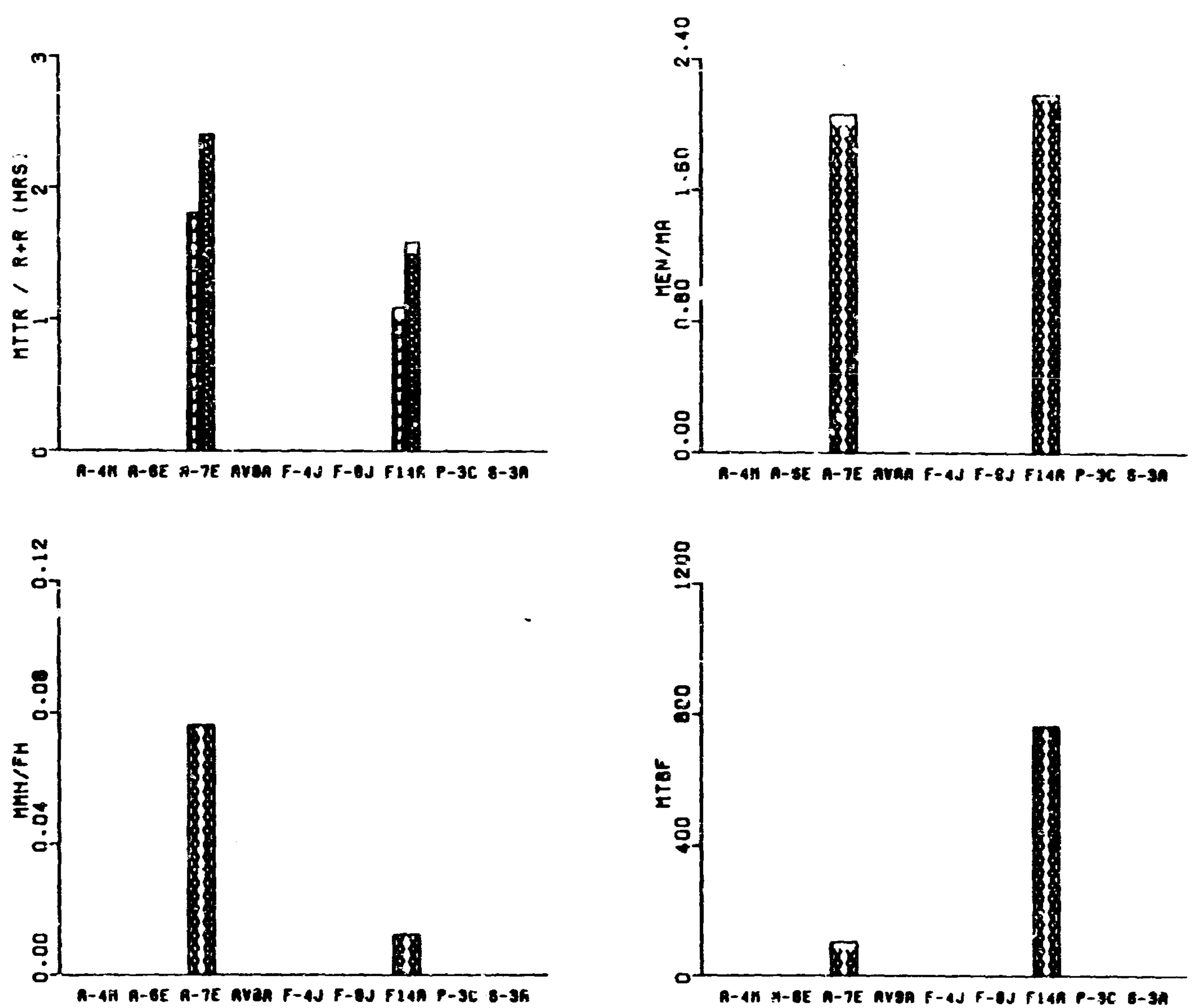


FIGURE 6.72 SELECTED GRAPHICAL DATA - TACTICAL/DIGITAL COMPUTERS

6.14.8 Tactical/Digital Computers (See preceding Table and Figure 6.72)

WORK UNIT CODES

A-4 N/A	A-6 N/A	A-7 73A21	AV-8 N/A	F-4 N/A
F-8 N/A	F-14 74A46	P-3 N/A	S-3 N/A	

DISCUSSION

Comments:

The difference between these two installations, when measured in terms of R+R time, can be attributed to use of BIT as the inclusive after installation check on the F-14A. However, even with that feature, the installation is not without blemish. Removal of the Digital Computer requires a workstand and access panel removal which consists of releasing 33 Calfax fasteners. On the strong side is the previously mentioned BIT and use of a hand crank to release the component from the rack. The A-7E installation has eight quick release fasteners in the access door and the equipment is located at ground level. It suffers in comparison to the F-14A in the use of two jack screw bolts and in the after installation check which requires loading the Operational Flight Program (OFP) into the computer with the aid of a test set, a self test and an operational test. If all the good maintainability features could be combined, an estimated savings of 20-25 minutes could be shaved from the R+R time of the F-14A and even more substantial savings could be realized on the time recorded for the A-7E.

Recommendations:

Minimize the number of quick release fasteners utilized to secure access panels/doors by using quick release latches whenever possible.

The handcrank technique used to engage/disengage the rack and panel connectors, as featured on the F-14A installation, should be considered a desirable addition to rack and panel installations.

Require comprehensive BIT provisions to minimize after installation checks and eliminate test equipment requirements.

Keep equipment installations at ground level or use drop out racks so that work stand needs can be minimized.

TABLE 6.73 MAINTENANCE DATA - TACTICAL/DIGITAL COMPUTER CONTROLS

WORK UNIT CODES

A-4	N/A	A-6	N/A	A-7	73A22	AV-8	N/A	F-4	N/A
F-8	N/A	F-14	74A52	P-3	N/A	S-3	N/A		

ORGANIZATIONAL LEVEL

A/C	FLIGHT HOURS	MFHBMA	MA/FH X10-3	MTTR	MMH/MA	MEN/MA	MMH/FH	R+R	O+I MTBF
A-4M	35,571								
A-6E	87,564								
A-7E	159,611	134.5	7.4	1.51	2.87	1.9	.021	1.97	254
AV-8A	19,396								
F-4J	115,070								
F-8J	18,317								
F-14A	51,286	153.1	6.5	1.11	3.25	2.9	.021	1.17	276
P-3C	125,860								
S-3A	60,552								

INTERMEDIATE LEVEL

A/C	FLIGHT HOURS	MFHBMA	MA/FH X10-3	MTTR	MMH/MA	MEN/MA	MMH/FH	R+R	O+I MTBF
A-4M	35,571								
A-6E	87,564								
A-7E	159,611	266.9	3.7	4.07	8.36	2.1	.031		
AV-8A	19,396								
F-4J	115,070								
F-8J	18,317								
F-14A	51,286	337.4	3.0	3.02	4.02	1.3	.012		
P-3C	125,860								
S-3A	60,552								

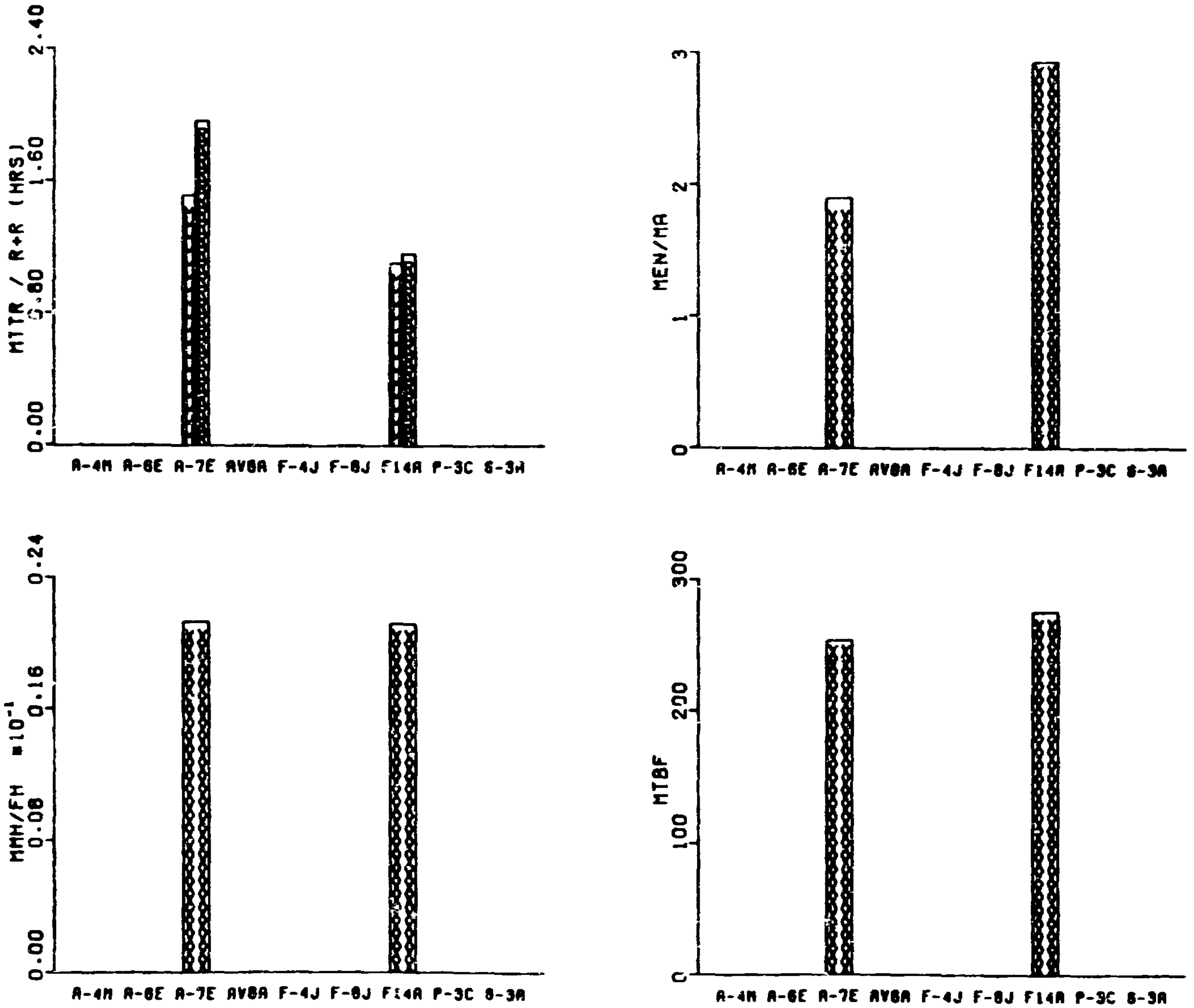


FIGURE 6.73 SELECTED GRAPHICAL DATA - TACTICAL/DIGITAL COMPUTER CONTROLS

6.14.9 Tactical/Digital Computer Controls (See preceding Table and Figure 6.73)

WORK UNIT CODES

A-4 N/A	A-6 N/A	A-7 73A22	AV-8 N/A	F-4 N/A
F-8 N/A	F-14 74A52	P-3 N/A	S-3 N/A	

DISCUSSION

Comments:

The A-7E installation is totally unsatisfactory. Three adjacent, unrelated control boxes must be removed to gain access to the connectors on the TAC Computer Control and, even then, the technician must reach down under the control to remove the connectors. This problem compounds itself when after installation checks are considered because each disturbed system must be checked. The F-14A installation, by contrast, is a model of efficiency and could be improved upon by designing the BIT function to be a bit more comprehensive, eliminating the limited operational check now required.

Recommendations:

Prohibit the removal of adjacent, unrelated components/hardware to achieve removal of a unit.

Require sufficient cable length to ensure unit can clear the mounting console or panel, and permit disconnection of cables with visual and physical access above the console/panel face. As an alternate, require rack and panel connectors even if use dictates design of an adapter to convert the wide variety of equipment connectors now in use to a rack and panel type mounting.

Establish requirement that BIT/BITE provisions for components/systems be comprehensive enough to satisfy all after installation check requirements.

TABLE 6.74 MAINTENANCE DATA - HEAD-UP PILOT DISPLAY UNITS

WORK UNIT CODES

A-4	N/A	A-6	72911	A-7	73A41	AV-8	739Z1	F-4	N/A
F-8	N/A	F-14	N/A	P-3	N/A	S-3	N/A		

ORGANIZATIONAL LEVEL

A/C	FLIGHT HOURS	MFHBMA	MA/FH X10-3	MTTR	MMH/MA	MEN/MA	MMH/FH	R+R	O+I MTBF
A-4M	35,571								
A-6E	87,564	18.6	53.8	1.31	2.61	2.0	.140	1.66	38
A-7E	159,611	37.4	26.8	1.58	3.10	2.0	.083	2.06	50
AV-8A	19,396	78.5	12.7	2.87	5.04	1.8	.064	4.75	155
F-4J	115,070								
F-8J	18,317								
F-14A	51,286								
P-3C	125,860								
S-3A	60,552								

INTERMEDIATE LEVEL

A/C	FLIGHT HOURS	MFHBMA	MA/FH X10-3	MTTR	MMH/MA	MEN/MA	MMH/FH
A-4M	35,571						
A-6E	87,564	35.1	28.5	5.31	7.48	1.4	.213
A-7E	159,611	54.1	18.5	3.54	6.79	1.9	.126
AV-8A	19,396	170.1	5.9	2.81	4.93	1.8	.029
F-4J	115,070						
F-8J	18,317						
F-14A	51,286						
P-3C	125,860						
S-3A	60,552						

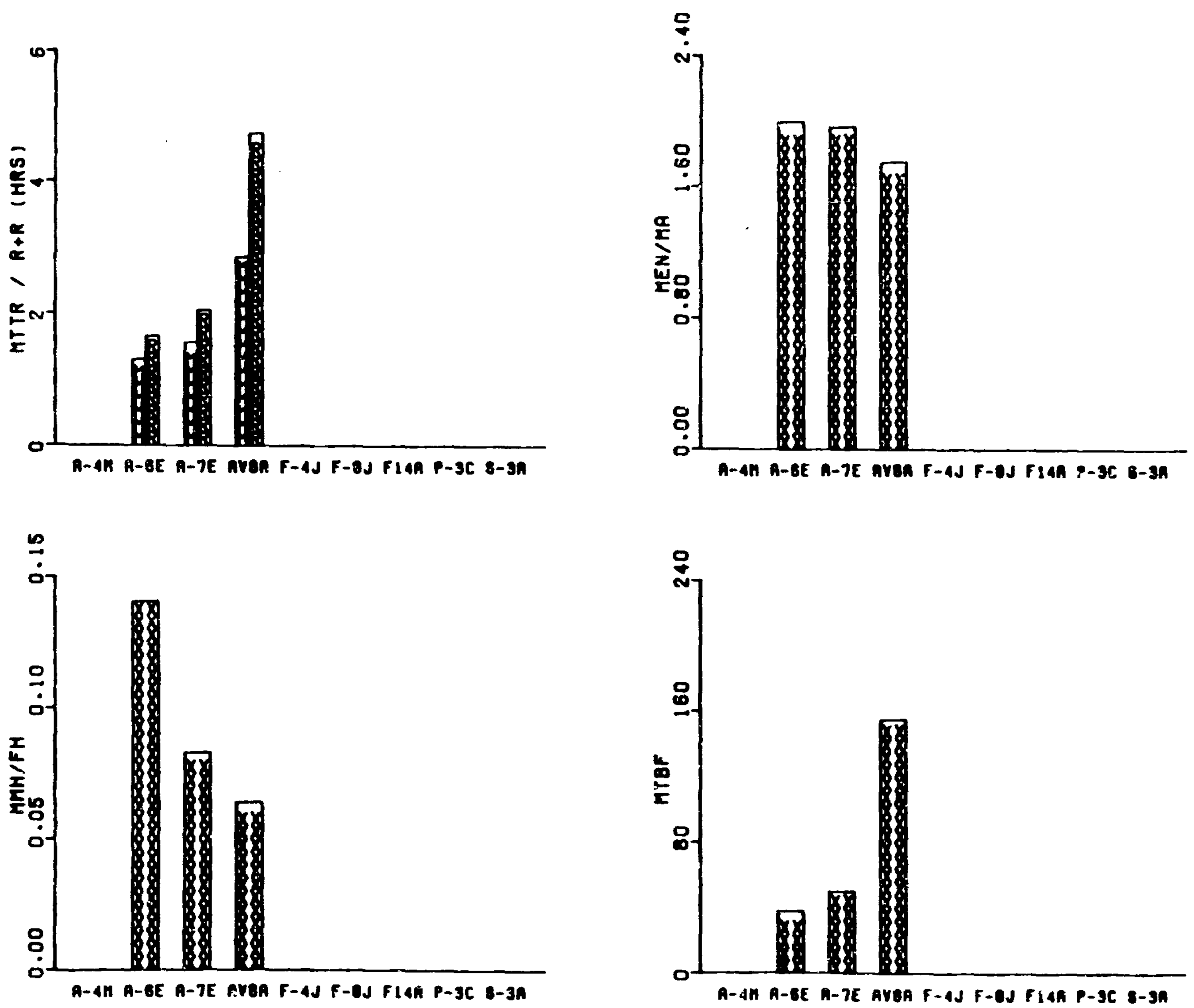


FIGURE 6.74 SELECTED GRAPHICAL DATA - HEAD-UP PILOT DISPLAY UNITS

6.14.10 Head-Up-Pilot Display Units (See preceding Table and Figure 6.74)

WORK UNIT CODES

A-4 N/A	A-6 72911	A-7 73A41	AV-8 73921	F-4 N/A
F-8 N/A	F-14 N/A	P-3 N/A	S-3 N/A	

DISCUSSION

Comments:

Although the A-6 installation is included in this grouping, the data recorded for the A-6 pertains to the Analog Display Indicator and is not representative of Head-Up-Display installations. Consequently, comparison can be made between the A-7E and AV-8A only. The AV-8A installation sequence is long and cumbersome requiring the removal of adjacent equipment and hardware items, and the use of a special tool to loosen the rear bolts on the Pilots Display Unit. In all, the analyst counted 18 individual steps in the removal and reinstallation sequence. By contrast, the A-7E requires seven steps to complete the same task and, even though the maintenance action also requires removal of adjacent hardware, the A-7E average time to affect the R+R action betters the time recorded for the AV-8A by over 2.5 hours.

Recommendations:

Prohibit removal of adjacent equipment or hardware items to gain access.

Specify use of rack and panel connectors wherever possible. Encourage further development thereof.

Use of special tools to accomplish an R+R action at Organizational level should be avoided unless it substantially simplifies or expedites maintenance. When used, special tools should be compatible to all mounting bolts to negate the need for the technician to carry two or more different tools.

BIT should be comprehensive enough to eliminate need for additional after installation checks, such as functional/operational checks.

TABLE 6.75 MAINTENANCE DATA - INERTIAL MEASUREMENT SET POWER SUPPLIES

WORK UNIT CODES

A-4	N/A	A-6	73453	A-7	73A54	AV-8	739W8	F-4	N/A
F-8	N/A	F-14	734H2	P-3	734F6	S-3	734H2		

ORGANIZATIONAL LEVEL

A/C	FLIGHT HOURS	MFHBMA	MA/FH X10-3	MTTR	MMH/MA	MEN/MA	MMH/FH	R+P	O+I MTBF
A-4M	35,571								
A-6E	87,564	65.5	15.3	2.06	4.42	2.2	.067	2.61	103
A-7E	159,611	34.5	28.9	1.86	3.63	1.9	.105	2.15	64
AV-8A	19,396	139.5	7.2	1.88	3.48	1.8	.025	3.23	146
F-4J	115,070								
F-8J	18,317								
F-14A	51,286	30.4	32.9	1.28	2.64	2.1	.087	1.59	48
P-3C	125,860	84.3	11.9	1.48	2.11	1.4	.025	2.11	218
S-3A	60,552	45.9	21.8	2.72	5.16	1.9	.112	2.05	139

INTERMEDIATE LEVEL

A/C	FLIGHT HOURS	MFHBMA	MA/FH X10-3	MTTR	MMH/MA	MEN/MA	MMH/FH
A-4M	35,571						
A-6E	87,564	79.4	12.6	4.83	7.05	1.5	.089
A-7E	159,611	50.6	19.7	8.56	11.11	1.3	.219
AV-8A	19,396	128.5	7.8	5.88	8.98	1.5	.070
F-4J	115,070						
F-8J	18,317						
F-14A	51,286	36.4	27.5	5.40	7.18	1.3	.197
P-3C	125,860	178.5	5.6	5.22	7.35	1.4	.041
S-3A	60,552	64.0	15.6	6.27	9.26	1.5	.145

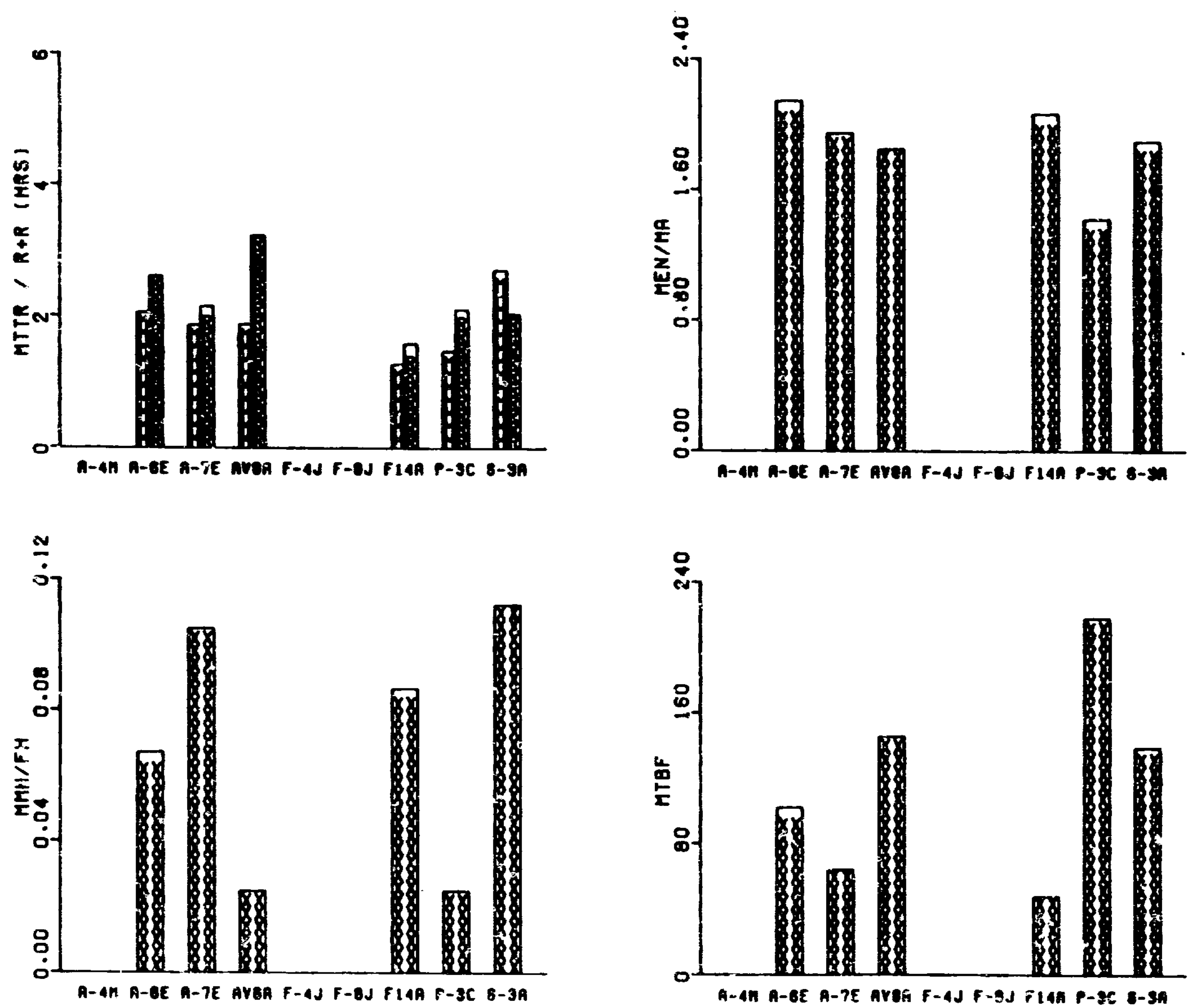


FIGURE 6.75 SELECTED GRAPHICAL DATA - INERTIAL MEASUREMENT SET POWER SUPPLIES

6.14.11 Inertial Measurement Set Power Supplies (See preceding Table and Figure 6.75)

WORK UNIT CODES

A-4 N/A	A-6 73453	A-7 73A54	AV-8 739W8	F-4 N/A
F-8 N/A	F-14 734H2	P-3 734F6	S-3 734H2	

DISCUSSION

Comments:

Qualitatively, all installations in this group were considered good and a review of the analysts comments do not provide any plausible clues that explain the wide variance, over 1.6 hours, that exists in the remove and replace times reflected here. The AV-8A appears, quantitatively, to have a complex installation or checkout. Yet, the qualitative evaluation shows that the reverse is true. On the other hand, the F-14A installation, reflecting the lowest R+R time, appears qualitatively to be the most complicated and time consuming installation surveyed. On that aircraft, removal requires use of a workstand, removal of a panel secured with 10 Calfax fasteners, disengaging three cable connectors, loosening two holddown screws and after replacement, a BIT check, an IMS alignment, and a drift check. By contrast, the S-3A installation, which utilizes the same IMS system and control, requires the removal of three connectors, two bolts, and after installation checks consist of an abbreviated sub-system test and BIT. Yet, the documented time against this simpler installation shows that, on an average, it takes almost 28 minutes longer to complete the task. Also unexplainable is the variance in the MTBF between the F-14A and S-3A, which employ the same system.

Recommendations:

Restrict the number of fasteners associated with frequently used access panels. If possible use latches rather than fasteners.

Encourage use of rack and panel connectors and further development thereof.

Require BIT/BITE provisions be comprehensive enough to satisfy all after installation check requirements, including integrated systems check.

Require that high frequency removal items be situated in convenient locations to facilitate and expedite maintenance. A review of the MTBF, predicted or from past experience with the same or similar system, should dictate the location decision.

TABLE 6.76 MAINTENANCE DATA - INERTIAL MEASUREMENT SET COMPUTERS

WORK UNIT CODES

A-4	N/A	A-6	N/A	A-7	N/A	AV-8	N/A	F-4	N/A
F-8	N/A	F-14	N/A	P-3	734F7	S-3	734H3		

ORGANIZATIONAL LEVEL

A/C	FLIGHT HOURS	MFHBMA	MA/FH X10-3	MTTR	MMH/MA	MEN/MA	MMH/FH	R+R	O+I MTBF
A-4M	35,571								
A-6E	87,564								
A-7E	159,611								
AV-8A	19,396								
F-4J	115,070								
F-8J	18,317								
F-14A	51,286								
P-3C	125,860	59.0	17.0	1.66	2.41	1.5	.041	2.27	124
S-3A	60,552	19.1	52.3	1.45	2.40	1.7	.125	2.03	51

INTERMEDIATE LEVEL

A/C	FLIGHT HOURS	MFHBMA	MA/FH X10-3	MTTR	MMH/MA	MEN/MA	MMH/FH
A-4M	35,571						
A-6E	87,564						
A-7E	159,611						
AV-8A	19,396						
F-4J	115,070						
F-8J	18,317						
F-14A	51,286						
P-3C	125,860	95.7	10.4	4.02	5.57	1.4	.058
S-3A	60,552	42.1	23.8	4.03	7.43	1.8	.177

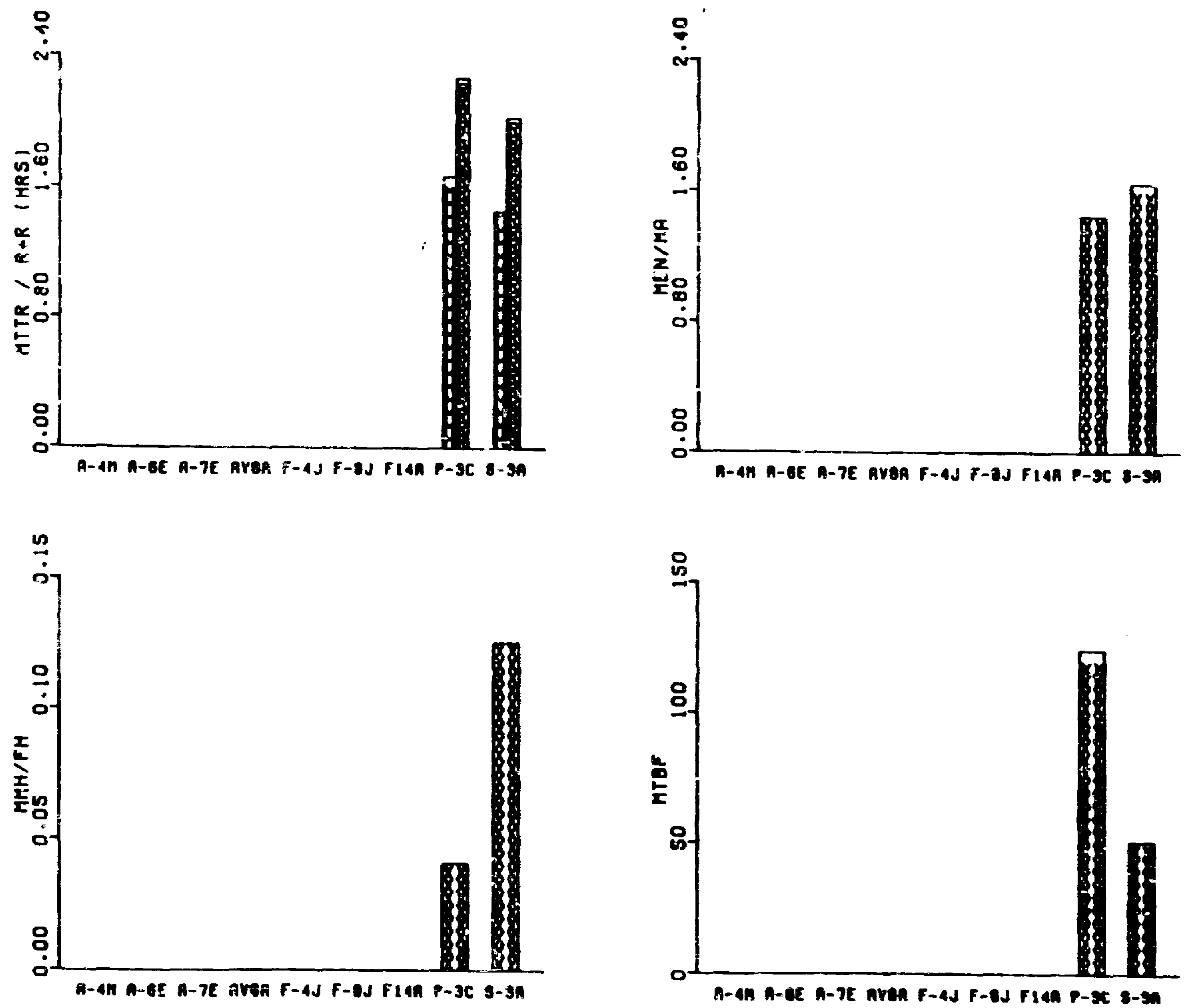


FIGURE 6.76 SELECTED GRAPHICAL DATA - INERTIAL MEASUREMENT SET COMPUTERS

6.14.12 Inertial Measurement Set Computers (See preceding Table and Figure 6.76)

WORK UNIT CODES

A-4 N/A	A-6 N/A	A-7 N/A	AV-8 N/A	F-4 N/A
F-8 N/A	F-14 N/A	P-3 734F7	S-3 734H3	

DISCUSSION

Comments:

Both installations have been optimized to facilitate the physical aspects of the R+R action. The after installation checks account for the majority of the time consumed accomplishing the maintenance action. Both installations employ knurled knobs as the means of retaining the equipment in the mounting rack, both utilize "up front" electrical connectors, and both have the units located between knee and chest heights. The installations thus take advantage of the space availability aboard both aircraft for the benefit of the maintenance technician.

Recommendations:

Require that BIT/BITE provisions be included in all component/systems design, and that they be comprehensive enough to eliminate, to the maximum extent possible, the need for follow-on operational/functional checks, including integrated systems checks.

TABLE 6.77 MAINTENANCE DATA - INERTIAL MEASUREMENT UNITS

WORK UNIT CODES

A-4	N/A	A-6	73455	A-7	73A51	AV-8	739W1	F-4	N/A
F-8	N/A	F-14	734H1	P-3	N/A	S-3	734H1		

ORGANIZATIONAL LEVEL

A/C	FLIGHT HOURS	MFHBMA	MA/FH X10-3	MTTR	MMH/MA	MEN/MA	MMH/FH	R+R	O+I MTBF
A-4M	35,571								
A-6E	87,564	46.4	21.6	2.63	5.64	2.1	.122	3.80	108
A-7E	159,611	37.2	26.9	2.06	4.10	2.0	.110	2.76	96
AV-8A	19,396	373.0	2.7	3.48	7.09	2.0	.019	5.84	1,021
F-4J	115,070								
F-8J	18,317								
F-14A	51,286	25.4	39.4	1.38	3.13	2.3	.124	1.96	66
P-3C	125,860								
S-3A	60,552	51.6	19.4	2.13	3.75	1.8	.073	2.91	120

INTERMEDIATE LEVEL

A/C	FLIGHT HOURS	MFHBMA	MA/FH X10-3	MTTR	MMH/MA	MEN/MA	MMH/FH
A-4M	35,571						
A-6E	87,564	98.8	10.1	8.31	12.87	1.5	.130
A-7E	159,611	82.8	12.1	8.24	13.08	1.6	.156
AV-8A	19,396	1,492.0	0.7	2.54	4.23	1.7	.003
F-4J	115,070						
F-8J	18,317						
F-14A	51,286	49.8	20.1	8.00	18.48	2.3	.371
P-3C	125,860						
S-3A	60,552	96.4	10.4	10.27	18.46	1.8	.191

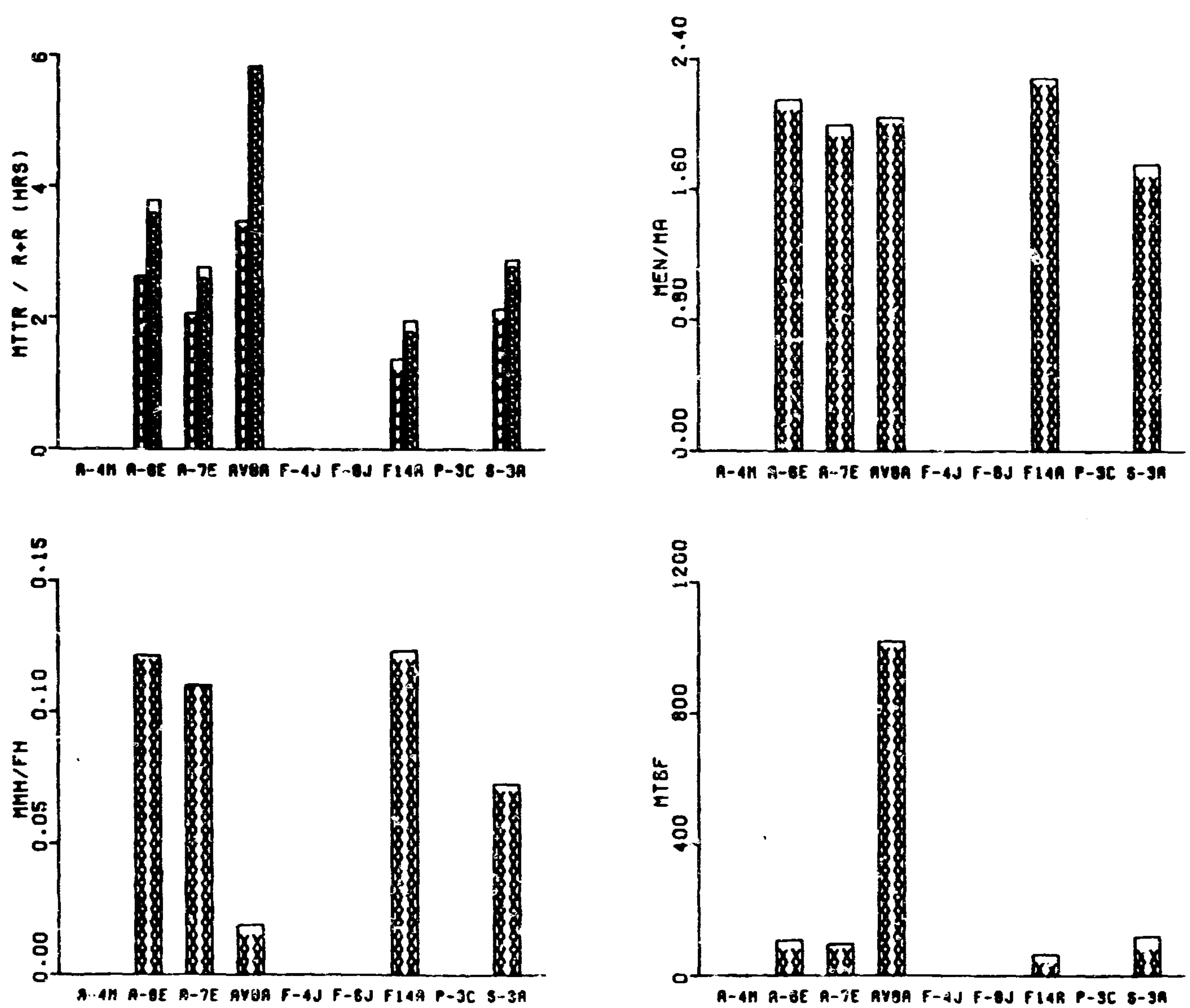


FIGURE 6.77 SELECTED GRAPHICAL DATA - INERTIAL MEASUREMENT UNITS

6.14.13 Inertial Measurement Units (See preceding Table and Figure 6.77)

WORK UNIT CODES

A-4 N/A	A-6 73455	A-7 73A51	AV-8 739W1	F-4 N/A
F-8 N/A	F-14 734H1	P-3 N/A	S-3 734H1	

DISCUSSION

<u>Comments</u>:

During the time frame that the data presented here was collected, the A-6E IMU installation was being relocated from the nose wheel well to a fillet above the engine. As a consequence, the data averages are not totally representative of the improved installation. The excessively high R+R time for the AV-8A is attributed to the fact that when the nose cone is removed to gain access to the unit in question, other systems are disrupted and upon close-up, must be operationally checked (Pitot-Static and Camera Systems). The saving grace is the extremely high MTBF enjoyed by the WRA involved.

<u>Recommendations</u>:

Eliminate the need to remove adjacent equipment to gain access. This may be accomplished in a variety of ways, one of which would be to utilize drop out racks where the unrelated equipments remain connected but swing out of the way to provide access. This would also eliminate the need to functionally check the system that is now disturbed t facilitate other maintenance.

Use of special hand tools to accomplish an Organizational level R+R action should be discouraged unless use provides substantial improvement in technique or savings in elapsed time. If special hand tools must be used they should be applicable to use on all mounting bolts involved in the action to eliminate the need for the technician to carry additional tools.

Require more convenient location and access for units with anticipated or realized low MTBF's.

TABLE 6.79 MAINTENANCE DATA - INERTIAL MEASUREMENT SET CONTROL BOXES

WORK UNIT CODES

A-4	N/A	A-6	73457	A-7	73A53	AV-8	N/A	F-4	N/A
F-8	N/A	F-14	N/A	P-3	N/A	S-3	N/A		

ORGANIZATIONAL LEVEL

A/C	FLIGHT HOURS	MFHBMA	MA/FH X10-3	MTTR	MMH/MA	MEN/MA	MMH/FH	R+R	O+I MTBF
A-4M	35,571								
A-6E	87,564	108.1	9.3	1.76	3.50	2.0	.032	2.09	146
A-7E	159,611	254.6	3.9	1.38	2.50	1.8	.010	1.86	685
AV-8A	19,396								
F-4J	115,070								
F-8J	18,317								
F-14A	51,286								
P-3C	125,860								
S-3A	60,552								

INTERMEDIATE LEVEL

A/C	FLIGHT HOURS	MFHBMA	MA/FH X10-3	MTTR	MMH/MA	MEN/MA	MMH/FH
A-4M	35,571						
A-6E	87,564	124.6	8.0	4.54	6.45	1.4	.052
A-7E	159,611	877.0	1.1	3.71	5.26	1.4	.006
AV-8A	19,396						
F-4J	115,070						
F-8J	18,317						
F-14A	51,286						
P-3C	125,860						
S-3A	60,552						

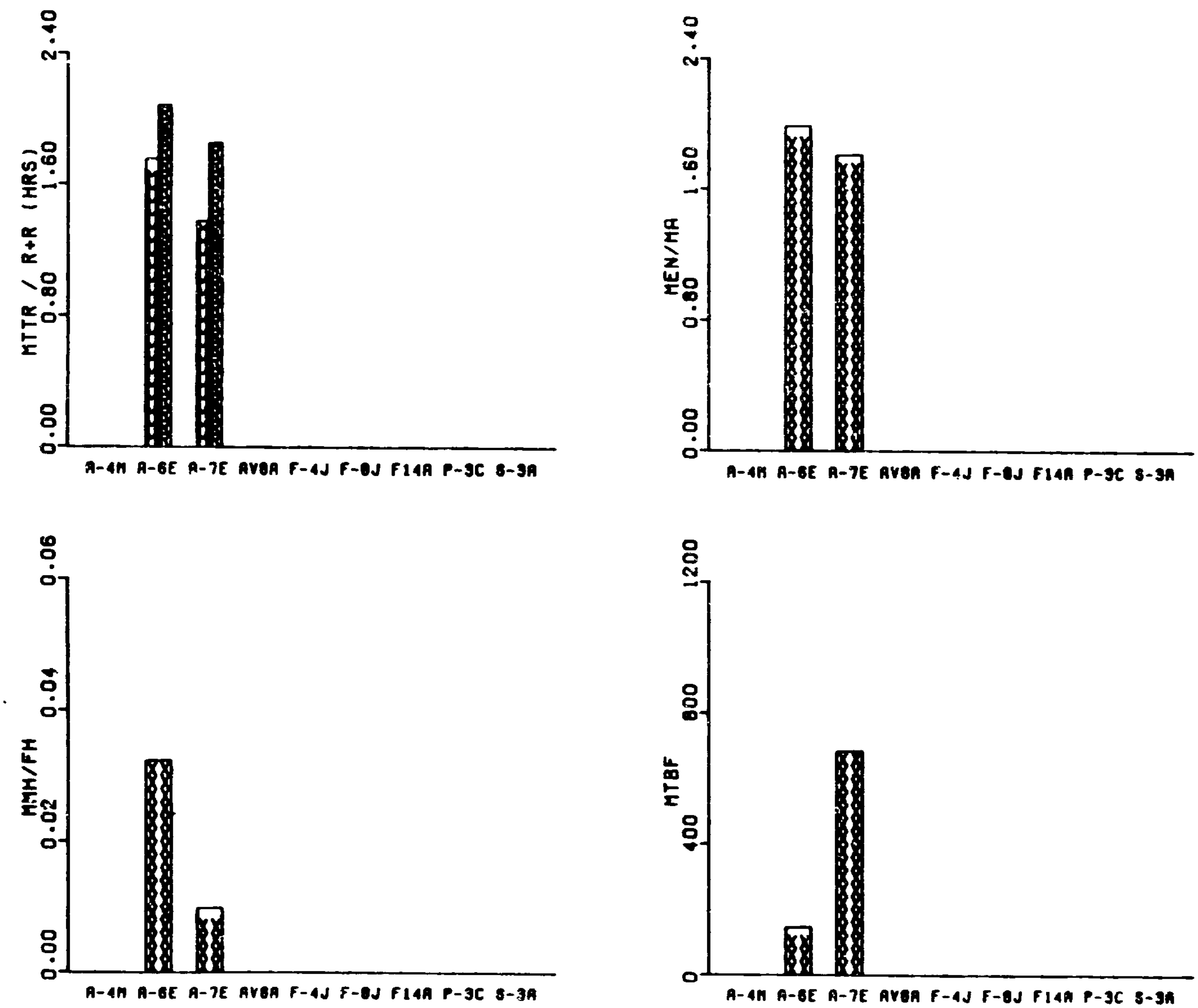


FIGURE 6.78 SELECTED GRAPHICAL DATA - INERTIAL MEASUREMENT SET CONTROL BOXES

6.14.14 Inertial Measurement Set Control Boxes (See preceding Table and Figure 6.78)

WORK UNIT CODES

A-4 N/A	A-6 73457	A-7 73A53	AV-8 N/A	F-4 N/A
F-8 N/A	F-14 N/A	P-3 N/A	S-3 N/A	

DISCUSSION

Comments:
The driving factor in these installations is the after installation checkout. In both cases the checkouts consume more clock time than the physical act of removal and replacement.

Recommendations:
Require that BIT/BITE provisions be included in all component/systems design, and that they be comprehensive enough to eliminate, to the maximum extent possible, the need for follow-on operational/functional checks.

TABLE 6.79 MAINTENANCE DATA - ALQ-XX COMPONENTS

WORK UNIT CODES

A-4	76731	A-6	76731	A-7	767L1	AV-8	N/A	F-4	76731
F-8	76731	F-14	76731	P-3	N/A	S-3	N/A		

ORGANIZATIONAL LEVEL

A/C	FLIGHT HOURS	MFHBMA	MA/FH X10-3	MTTR	MMH/MA	MEN/MA	MMH/FH	R+R	O+I MTBF
A-4M	35,571	1,111.6	0.9	3.55	7.04	2.0	.006	2.21	1,078
A-6E	87,564	21,891.0	0.0	1.80	2.80	1.6	.000	4.00	12,509
A-7E	159,611	233.3	4.3	2.09	4.26	2.0	.018	2.68	171
AV-8A	19,396								
F-4J	115,070	1,000.6	1.0	3.55	8.36	2.4	.008	3.25	405
F-8J	18,317	53.9	18.6	1.96	4.26	2.2	.079	1.99	54
F-14A	51,286	66.6	15.0	2.27	5.47	2.4	.082	2.25	44
P-3C	125,860								
S-3A	60,552								

INTERMEDIATE LEVEL

A/C	FLIGHT HOURS	MFHBMA	MA/FH X10-3	MTTR	MMH/MA	MEN/MA	MMH/FH
A-4M	35,571	790.5	1.3	13.67	19.39	1.4	.025
A-6E	87,564	10,945.5	0.1	6.20	10.06	1.6	.001
A-7E	159,611	154.4	6.5	5.56	9.12	1.6	.059
AV-8A	19,396						
F-4J	115,070	356.3	2.8	7.91	10.46	1.3	.029
F-8J	18,317	37.7	26.5	5.61	10.22	1.8	.271
F-14A	51,286	39.7	25.2	8.17	12.69	1.6	.320
P-3C	125,860						
S-3A	60,552						

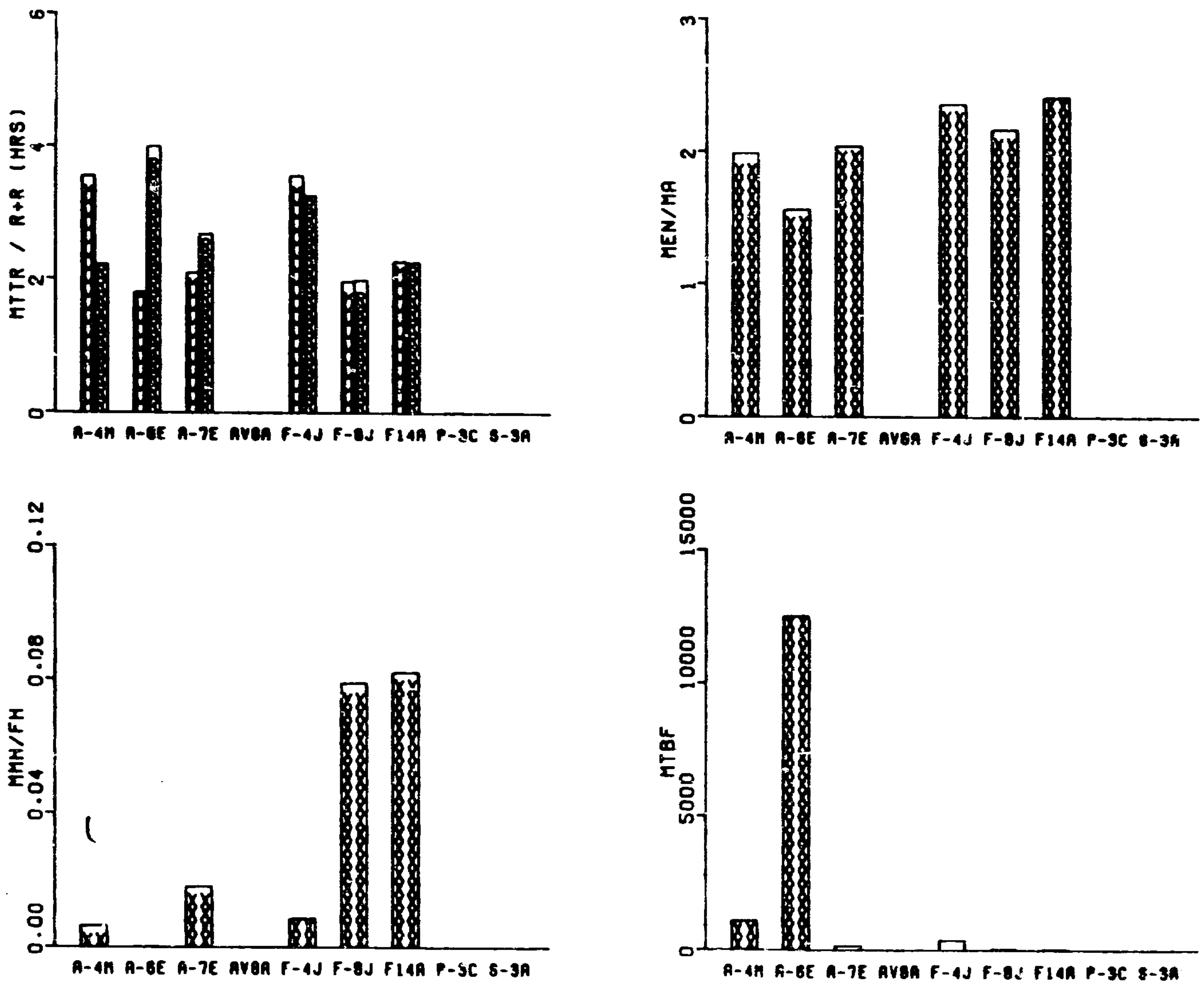


FIGURE 6.79 SELECTED GRAPHICAL DATA - ALQ-XX COMPONENTS

6.15 ELECTRONIC COUNTERMEASURES SYSTEM

6.15.1 ALQ-XX Components (See preceding Table and Figure 6.79)

WORK UNIT CODES

A-4 76731	A-6 76731	A-7 767L1	AV-8 N/A	F-4 76731
F-8 76731	F-14 76731	P-3 N/A	S-3 N/A	

DISCUSSION

<u>Comments</u>:

The data base from which the R+R time for the A-4M and A-6E components was computed consists of seven actions and one action respectively. Neither is considered a valid statistical sample. The high time recorded to remove and replace the ALQ-100 in the F-4J is due primarily to location of the unit in the aircraft (upper dorsal area) and the necessity to remove an adjacent unit to accomplish the action. Incongruity is reflected in the MTBF data in that even with similarity in aircraft types (F-4, F-8, F-14) the MTBF varies by factors of 7.5 and 9. When consideration is given to the fact that the systems are identical in all three installations, one must look elsewhere for the solution.

<u>Recommendations</u>:

Require BIT/BITE provisions to be comprehensive enough to negate the need for other after installation checks. This would also eliminate the need for test equipment.

Minimize the number of fasteners involved to gain access to equipment. This could be accomplished by using one or more of the following techniques: use hinged doors with quick release latches, use quick release fasteners rather than screws, or break large panels into several smaller ones secured with quick release fasteners.

Eliminate need to remove other unrelated equipment/hardware to gain access or affect removal of equipment.

TABLE 6.80 MAINTENANCE DATA - ALQ-XX RF CONVERTER

WORK UNIT CODES

A-4	N/A	A-6	N/A	A-7	N/A	AV-8	N/A	F-4	N/A
F-8	N/A	F-14	N/A	P-3	76613	S-3	N/A		

ORGANIZATIONAL LEVEL

A/C	FLIGHT HOURS	MFHBMA	MA/FH X10-3	MTTR	MMH/MA	MEN/MA	MMH/FH	R+R	O+I MTBF
A-4M	35,571								
A-6E	87,564								
A-7E	159,611								
AV-8A	19,396								
F-4J	115,070								
F-8J	18,317								
F-14A	51,286								
P-3C	125,860	282.8	3.5	2.71	4.38	1.6	.016	3.92	520
S-3A	60,552								

INTERMEDIATE LEVEL

A/C	FLIGHT HOURS	MFHBMA	MA/FH X10-3	MTTR	MMH/MA	MEN/MA	MMH/FH	R+R	O+I MTBF
A-4M	35,571								
A-6E	87,564								
A-7E	159,611								
AV-8A	19,396								
F-4J	115,070								
F-8J	18,317								
F-14A	51,286								
P-3C	125,860	740.4	1.4	0.12	0.19	1.6	.000		
S-3A	60,552								

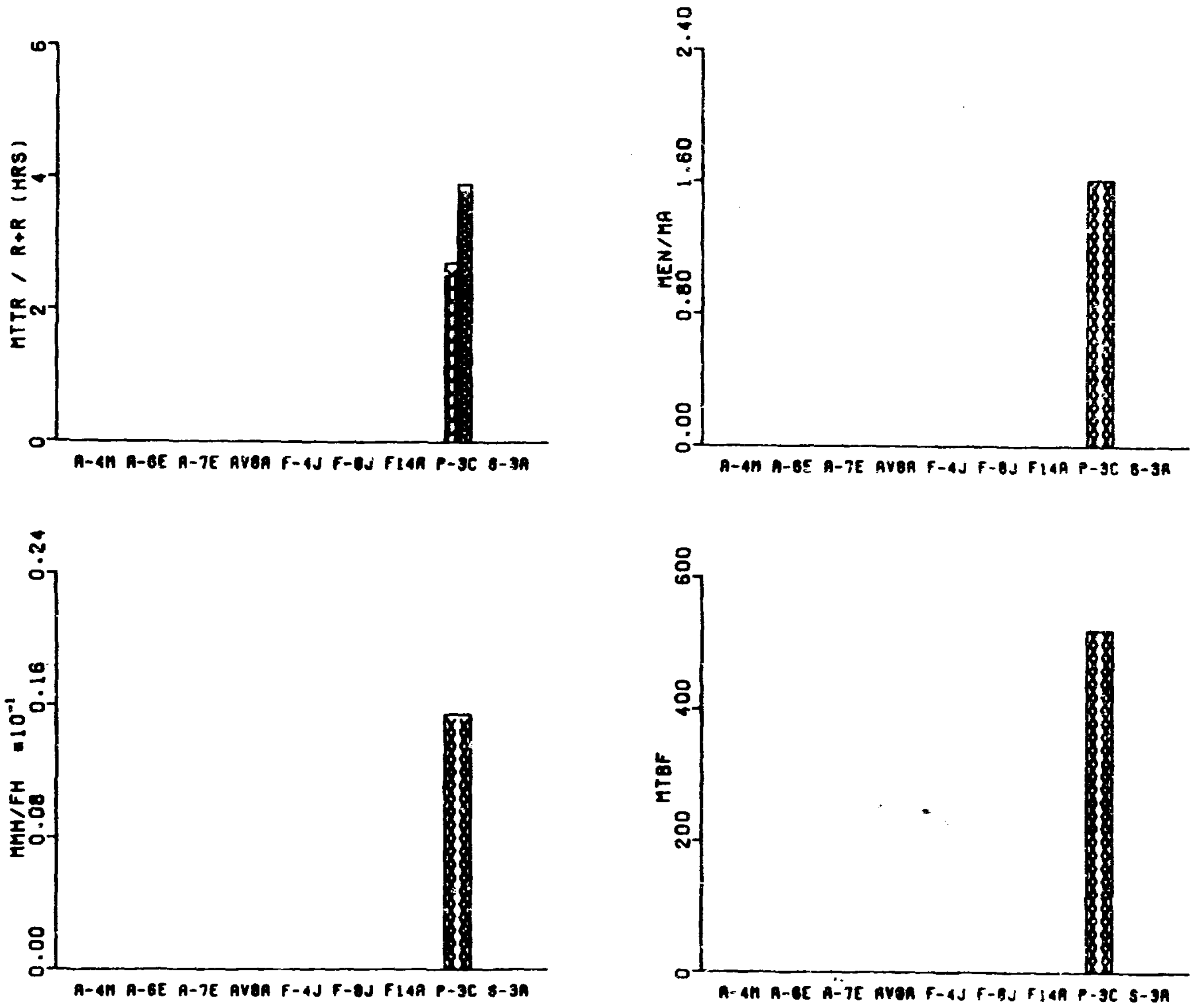


FIGURE 6.80 SELECTED GRAPHICAL DATA - ALQ-XX RF CONVERTER

6.15.2 ALQ-XX RF Converter (See preceding Table and Figure 6.80)

WORK UNIT CODES

A-4 N/A	A-6 N/A	A-7 N/A	AV-8 N/A	F-4 N/A
F-8 N/A	F-14 N/A	P-3 76613	S-3 N/A	

DISCUSSION

Comments:

This item was surveyed on only one aircraft. Consequently, no comparison relative to the quantitative aspects of the installation can be made. Qualitatively, the installation leaves room for improvement. The unit is large, bulky and heavy with numerous connections. It is deck mounted and access to waveguides and cable connectors is difficult in spite of the fact that an attempt was made to provide access to three sides of the unit. To remove the connectors and waveguides, technicians lay on their side protruding into the Electronic Rack compartment. Even then, some of the connectors are hidden. With the space availability aboard the P-3C this is unacceptable.

Recommendations:

When large, bulky and heavy units such as this RF converter are involved, maintainability of the installation must be emphasized. The rear mounted connections should face the technician; the rack should be designed to swivel allowing front access removal; and, whenever possible, the unit should be located at a convenient height to avoid technician stooping, bending or kneeling.

TABLE 6.81 MAINTENANCE DATA - ALQ-XX VIDEO LOCAL OSCILLATOR

WORK UNIT CODES

A-4	N/A	A-6	N/A	A-7	N/A	AV-8	N/A	F-4	N/A
F-8	N/A	F-14	N/A	P-3	76614	S-3	N/A		

ORGANIZATIONAL LEVEL

A/C	FLIGHT HOURS	MFHBMA	MA/FH X10-3	MTTR	MMH/MA	MEN/MA	MMH/FH	R+R	O+I MTBF
A-4M	35,571								
A-6E	87,564								
A-7E	159,611								
AV-8A	19,396								
F-4J	115,070								
F-8J	18,317								
F-14A	51,286								
P-3C	125,860	179.3	5.7	1.93	2.96	1.5	.017	3.24	43[illegible]
S-3A	60,552								

INTERMEDIATE LEVEL

A/C	FLIGHT HOURS	MFHBMA	MA/FH X10-3	MTTR	MMH/MA	MEN/MA	MMH/FH
A-4M	35,571						
A-6E	87,564						
A-7E	159,611						
AV-8A	19,396						
F-4J	115,070						
F-8J	18,317						
F-14A	51,286						
P-3C	125,860	648.8	1.5	0.16	0.17	1.0	.000
S-3A	60,552						

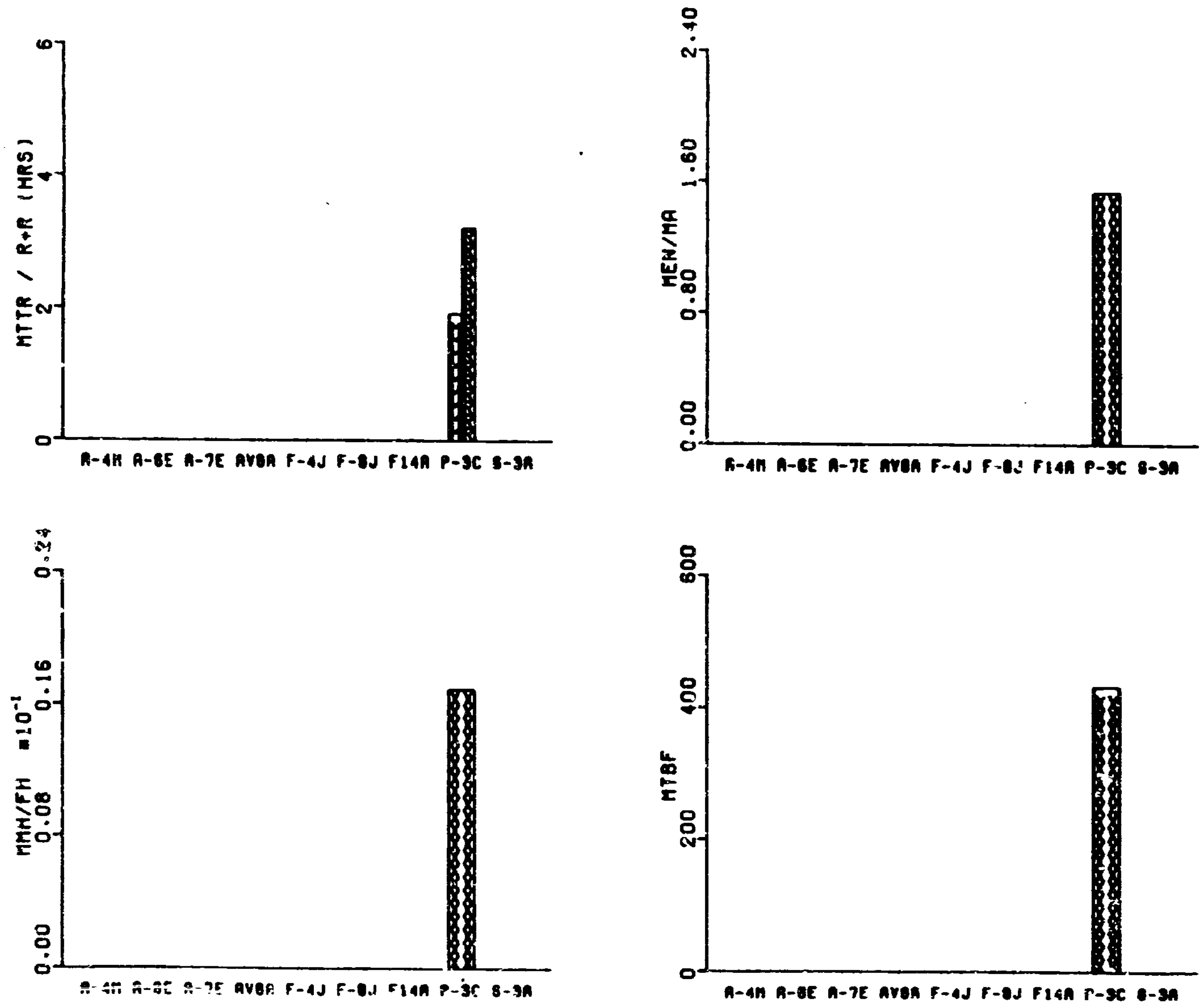


FIGURE 6.81 SELECTED GRAPHICAL DATA - ALQ-XX VIDEO LOCAL OSCILLATOR

6.15.3 ALQ-XX Video Local Oscillator (See preceding Table and Figure 6.81)

WORK UNIT CODES

A-4 N/A	A-6 N/A	A-7 N/A	AV-8 N/A	F-4 N/A
F-8 N/A	F-14 N/A	P-3 76614	S-3 N/A	

DISCUSSION

Comments:

This item was surveyed on only one aircraft. Consequently, no comparison relative to the quantitative aspects of the installation can be made. However, from a qualitative standpoint, the installation is good with the majority of the time reflected under the R+R column spent in accomplishment of the operational check required after installation. The removal action suffers slightly from the need to disconnect nine separate electrical connectors to effect removal.

Recommendations:

Utilize rack and panel connectors wherever and whenever possible. Individual component/systems designed to be provided as GFE should also employ this technique. Encourage further development of the rack and panel mounting concept.

Require that BIT/BITE provisions be included in all component/systems design, and that they be comprehensive enough to eliminate all need to accomplish an operational/functional check.

TABLE 6.82 MAINTENANCE DATA - ALR-XX COMPONENTS

WORK UNIT CODES

A-4	N/A	A-6	763L1	763L3	A-7	763L1	763L3	763W1	AV-8
N/A	F-4	763L1	763L3	763W1	F-8	N/A	F-14	763L1	763W1
P-3	N/A	S-3	768G1	768G3					

ORGANIZATIONAL LEVEL

A/C	FLIGHT HOURS	MFHBMA	MA/FH X10-3	MTTR	MMH/MA	MEN/MA	MMH/FH	R+R	O+I MTBF
A-4M	35,571								
A-6E	87,564	90.6	11.0	2.40	4.69	2.0	.052	2.77	100
A-7E	159,611	84.4	11.9	1.77	3.46	2.0	.041	2.43	117
AV-8A	19,396								
F-4J	115,070	77.8	12.9	3.61	7.32	2.0	.094	3.90	119
F-8J	18,317								
F-14A	51,286	48.7	20.6	1.57	3.41	2.2	.070	2.09	60
P-3C	125,860								
S-3A	60,552	55.7	18.0	1.74	3.28	1.9	.059	2.77	102

INTERMEDIATE LEVEL

A/C	FLIGHT HOURS	MFHBMA	MA/FH X10-3	MTTR	MMH/MA	MEN/MA	MMH/FH
A-4M	35,571						
A-6E	87,564	97.0	10.3	4.25	6.38	1.5	.064
A-7E	159,611	114.4	8.7	3.99	5.72	1.4	.050
AV-8A	19,396						
F-4J	115,070	105.6	9.5	3.59	5.51	1.5	.052
F-8J	18,317						
F-14A	51,286	66.6	15.0	4.96	7.65	1.5	.115
P-3C	125,860						
S-3A	60,552	96.1	10.4	3.37	5.42	1.6	.056

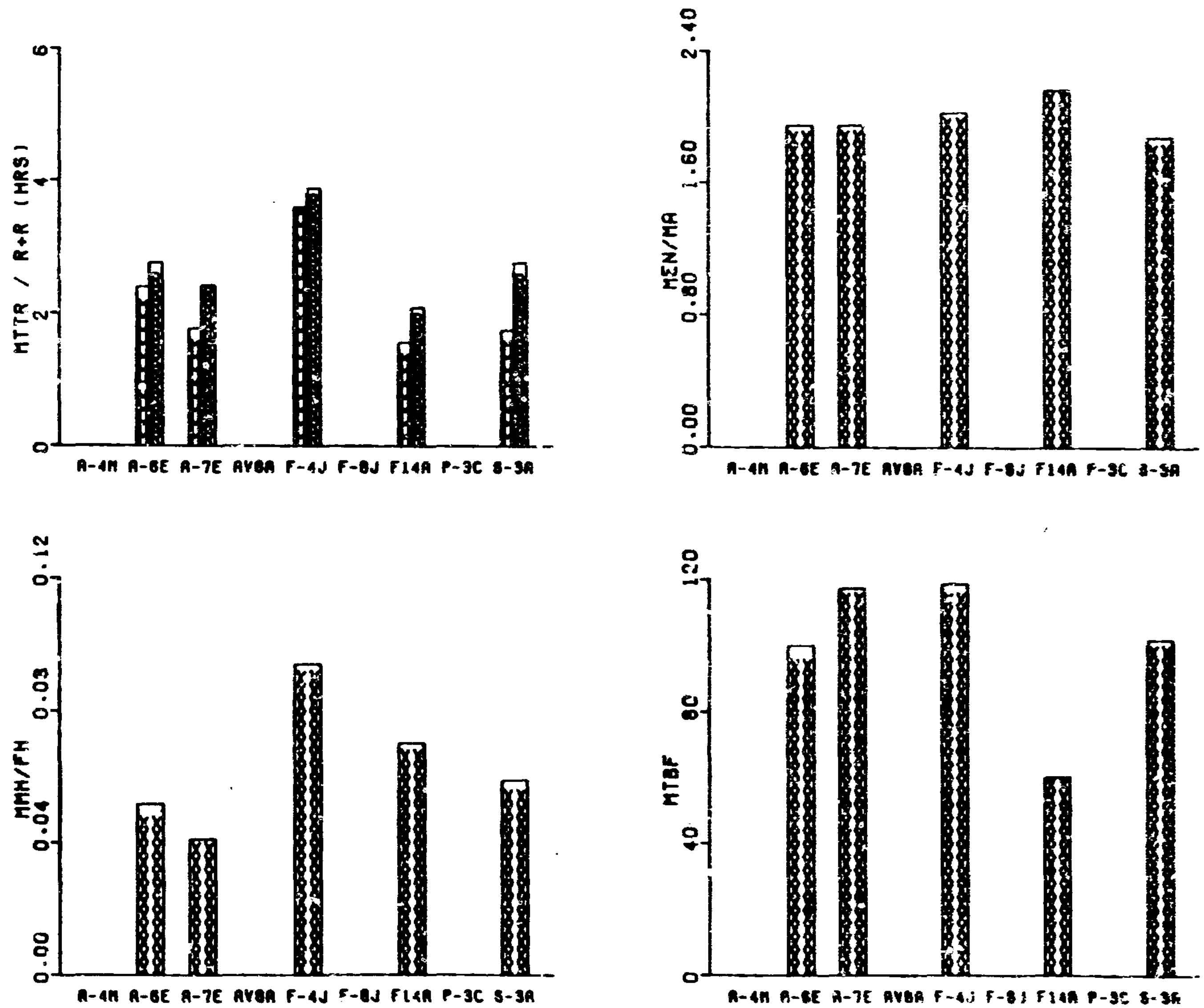


FIGURE 6.C2 SELECTED GRAPHICAL DATA - ALR-XX COMPONENTS

6.15.4 ALR-XX Components (See preceding Table and Figure 6.82)

WORK UNIT CODES

A-4 N/A	A-6 763L1, 763L3	A-7 763L1, 763L3, 763W1	AV-8 N/A	F-4 763L1, 763L3, 763W1
F-8 N/A	F-14 763L1, 763W1	P-3 N/A	S-3 768G1, 768G3	

DISCUSSION

Comments:

Most of the times reflected for R+R and MTBF are consistent with the qualitative analyses. The high R+R time for the F-4J is due primarily to the ALR-50 Radar Receiver installation which is inaccessible, and the numerous after installation checks required on those unrelated systems that have to be disturbed to affect removal. If the R+R time for this one action (ALR-50 Radar Receiver) is isolated the documented time to accomplish the task is 5.99 hours elapsed time. The elements that go into making this task so completely unacceptable from a maintainability point of view is the need to remove 42 fasteners securing the access panel, five units from unrelated systems, a waveguide, and one equipment rack, merely to gain access to the receiver.

Recommendations:

Eliminate need to remove adjacent equipments/hardware to gain access. This would also eliminate need to functionally check the systems that are now disturbed to facilitate the maintenance action on the prime WRA.

When equipment is added by ECP action, or space availability dictates the need to "bury" the unit in an internal location which requires movement or removal of other units/systems to gain access, require that equipment racks be designed that swing out, lift out, or slide up and out. This would provide access to the internally situated equipments without the need to disconnect the adjacent unit/system.

TABLE 6.83 MAINTENANCE DATA - INFARED DETECTING SYSTEMS, IR VIEWER

WORK UNIT CODES

A-4	N/A	A-6	N/A	A-7	N/A	AV-8	N/A	F-4	N/A
F-8	N/A	F-14	N/A	P-3	N/A	S-3	77311		

ORGANIZATIONAL LEVEL

A/C	FLIGHT HOURS	MFHBMA	MA/FH X10-3	MTTR	MMH/MA	MEN/MA	MMH/FH	R+R	O+I MTBF
A-4M	35,571								
A-6E	87,564								
A-7E	159,611								
AV-8A	19,396								
F-4J	115,070								
F-8J	18,317								
F-14A	51,286								
P-3C	125,860								
S-3A	60,552	126.7	7.9	3.54	8.39	2.4	.066	4.83	157

INTERMEDIATE LEVEL

A/C	FLIGHT HOURS	MFHBMA	MA/FH X10-3	MTTR	MMH/MA	MEN/MA	MMH/FH	R+R	O+I MTBF
A-4M	35,571								
A-6E	87,564								
A-7E	159,611								
AV-8A	19,396								
F-4J	115,070								
F-8J	18,317								
F-14A	51,286								
P-3C	125,860								
S-3A	60,552	152.5	6.6	7.66	12.65	1.7	.083		

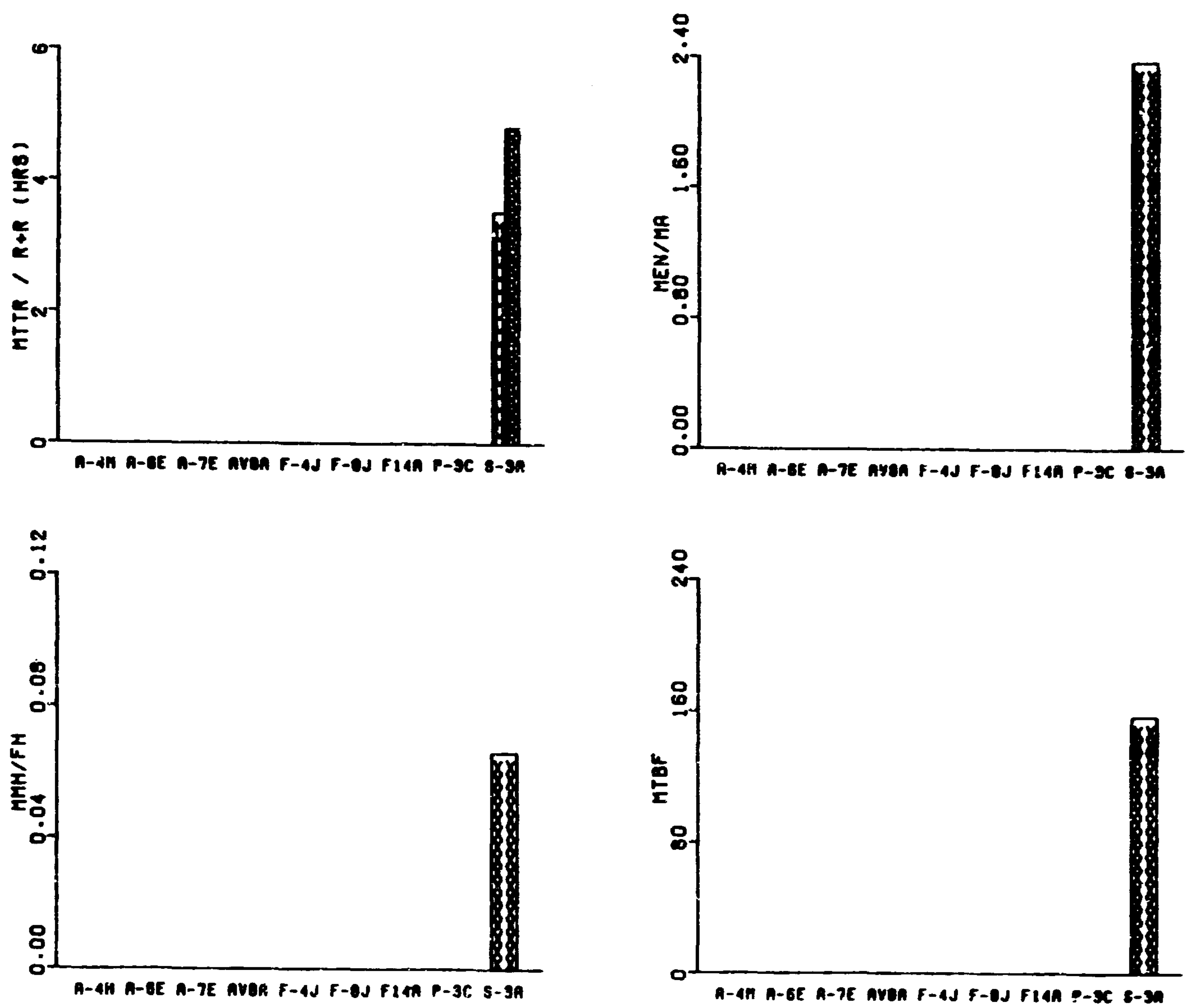


FIGURE 6.83 SELECTED GRAPHICAL DATA - INFARED DETECTING SYSTEMS, IR VIEWER

6.16 PHOTOGRAPHIC RECONNAISSANCE

6.16.1 Infrared Detecting Systems, IR Viewer (See preceding Table and Figure 6.83)

WORK UNIT CODES

A-4 N/A	A-6 N/A	A-7 N/A	AV-8 N/A	F-4 N/A
F-8 N/A	F-14 N/A	P-3 N/A	S-3 77311	

DISCUSSION

Comments:

This item was surveyed on only one aircraft which inhibits comparative analysis using quantitative data. However, notice must be taken of the complexity of this particular installation. The removal and replacement task consists of over 40 separate steps and accomplishment requires three technicians. Accessibility is less than marginal and the length of the action, in elapsed time, makes it tedious to the technicians and forces them into a situation that increases the chance for error.

TABLE 6.84 MAINTENANCE DATA – IR CONTROL CONVERTER

WORK UNIT CODES

A-4	N/A	A-6	N/A	A-7	N/A	AV-8	N/A	F-4	N/A
F-8	N/A	F-14	N/A	P-3	N/A	S-3	77313		

ORGANIZATIONAL LEVEL

A/C	FLIGHT HOURS	MFHBMA	MA/FH X10-3	MTTR	MMH/MA	MEN/MA	MMH/FH	R+R	O+I MTBF
A-4M	35,571								
A-6E	87,564								
A-7E	159,611								
AV-8A	19,396								
F-4J	115,070								
F-8J	18,317								
F-14A	51,286								
P-3C	125,860								
S-3A	60,352	122.1	8.2	1.20	2.12	1.8	.017	2.28	234

INTERMEDIATE LEVEL

A/C	FLIGHT HOURS	MFHBMA	MA/FH X10-3	MTTR	MMH/MA	MEN/MA	MMH/FH	R+R	O+I MTBF
A-4M	35,571								
A-6E	87,564								
A-7E	159,611								
AV-8A	19,396								
F-4J	115,070								
F-8J	18,317								
F-14A	51,286								
P-3C	125,860								
S-3A	60,352	221.0	4.5	4.45	7.16	1.6	.032		

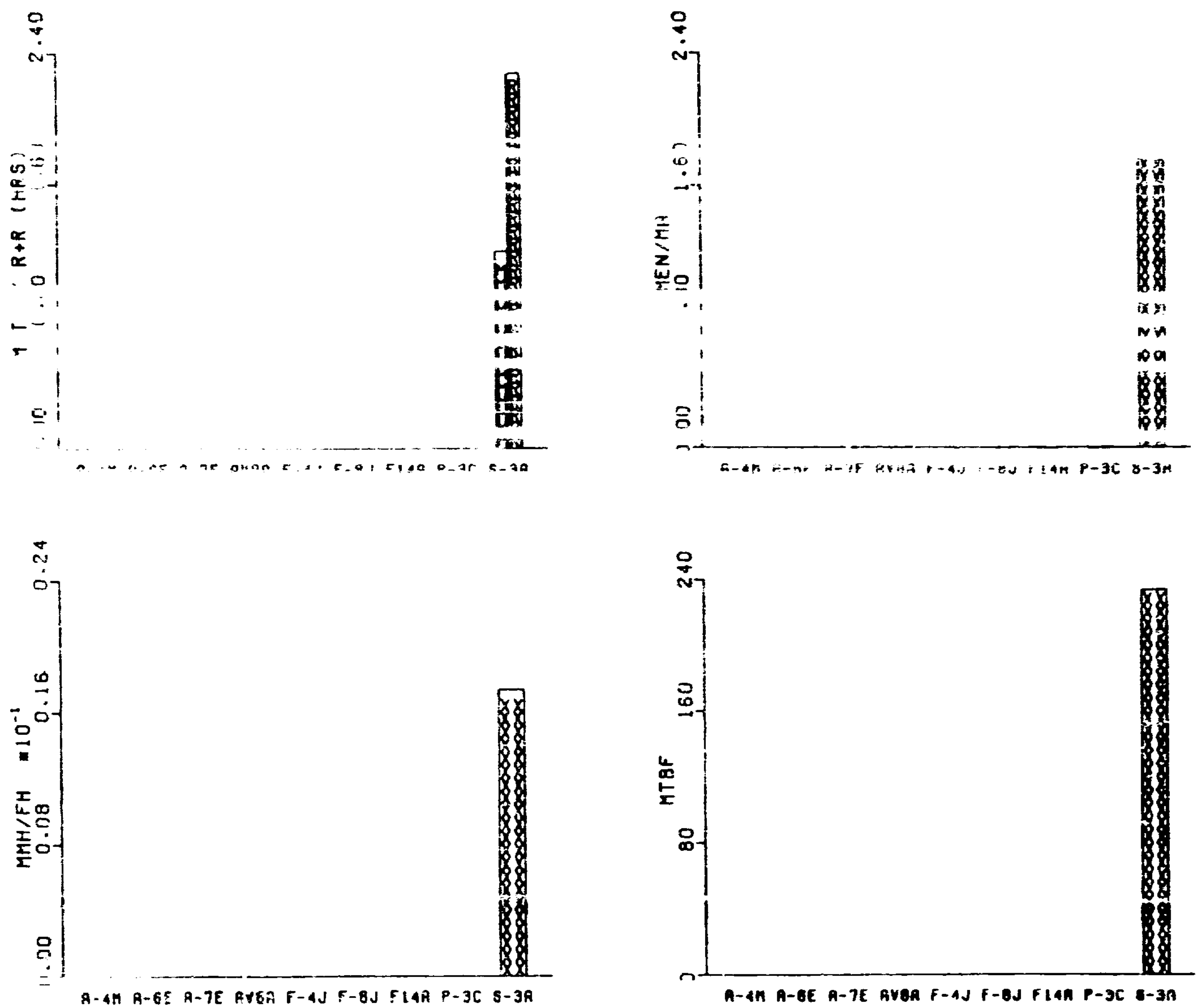


FIGURE 5.84 SELECTED GRAPHICAL DATA - IR CONTROL CONVERTER

6.16.2 IR Control Converter (See preceding Table and Figure 6.84)

WORK UNIT CODES

A-4 N/A	A-6 N/A	A-7 N/A	AV-8 N/A	F-4 N/A
F-8 N/A	F-14 N/A	P-3 N/A	S-3 77313	

DISCUSSION

Comments:

This item was surveyed on only one aircraft, consequently, no comparison relative to the quantitative aspects of the installation can be made. However, from a qualitative standpoint, the installation is excellent, utilizing rack and panel connectors and equipment lock lugs to secure the unit. The majority of the time reflected as the R+R average is spent accomplishing the after installation checkout.

Recommendations:

Require that BIT/BITE provisions be included in all component/systems design, and that they be comprehensive enough to eliminate, to the maximum extent possible, the need for follow-on operational/functional checks, including integrated systems checks.

TABLE 6 85 MAINTE[illegible]ANCE DATA - I[illegible] POWER SUPPLY

WO[illegible]K U[illegible]I[illegible] CODES

A-4	N/A	A-[illegible]	N/A	[illegible]-7	N/A	AV-8	N/A	F-4	N/A
F-8	N/A	F-[illegible]	N/A	[illegible]-3	N/A	S-3	77314		

[illegible]R ANIZ[illegible]T[illegible] [illegible]IAL LEVEL

A/C	F[illegible]IGHT H[illegible]U[illegible]S	MF[illegible]	MA/F[illegible] X10-[illegible]	MTTR	MMH/MA	MEN/MA	MMH/FH	R+R	O+I MTBF
A-4M	3[illegible],[illegible]71								
A-6E	8[illegible],[illegible]64								
A-7E	15[illegible],611								
AV-8A	1[illegible],396								
F-4J	11[illegible],070								
F-8J	[illegible],327								
F-14A	5[illegible],286								
P-3C	12[illegible],860								
S-3A	6[illegible],552	5[illegible]0[illegible]	1.[illegible]	1.51	2.30	1.3	.004	2.76	904

[illegible]N[illegible]ERME[illegible]I[illegible]T[illegible] LEVEL

A/C	F[illegible]IGHT H[illegible]U[illegible]S	MF[illegible]	MA/F[illegible] X10-[illegible]	MTTR	MMH/MA	MEN/MA	MMH/FH	R+R	O+I MTBF
A-4M	3[illegible],571								
A-6E	8[illegible],564								
A-7E	15[illegible],611								
AV-8A	1[illegible],396								
F-4J	11[illegible],070								
F-8J	[illegible],317								
F-14A	5[illegible],286								
P-3C	12[illegible],660								
S-3A	6[illegible],532	6[illegible]0[illegible]	1.[illegible]	3.70	5.36	1.4	.008		

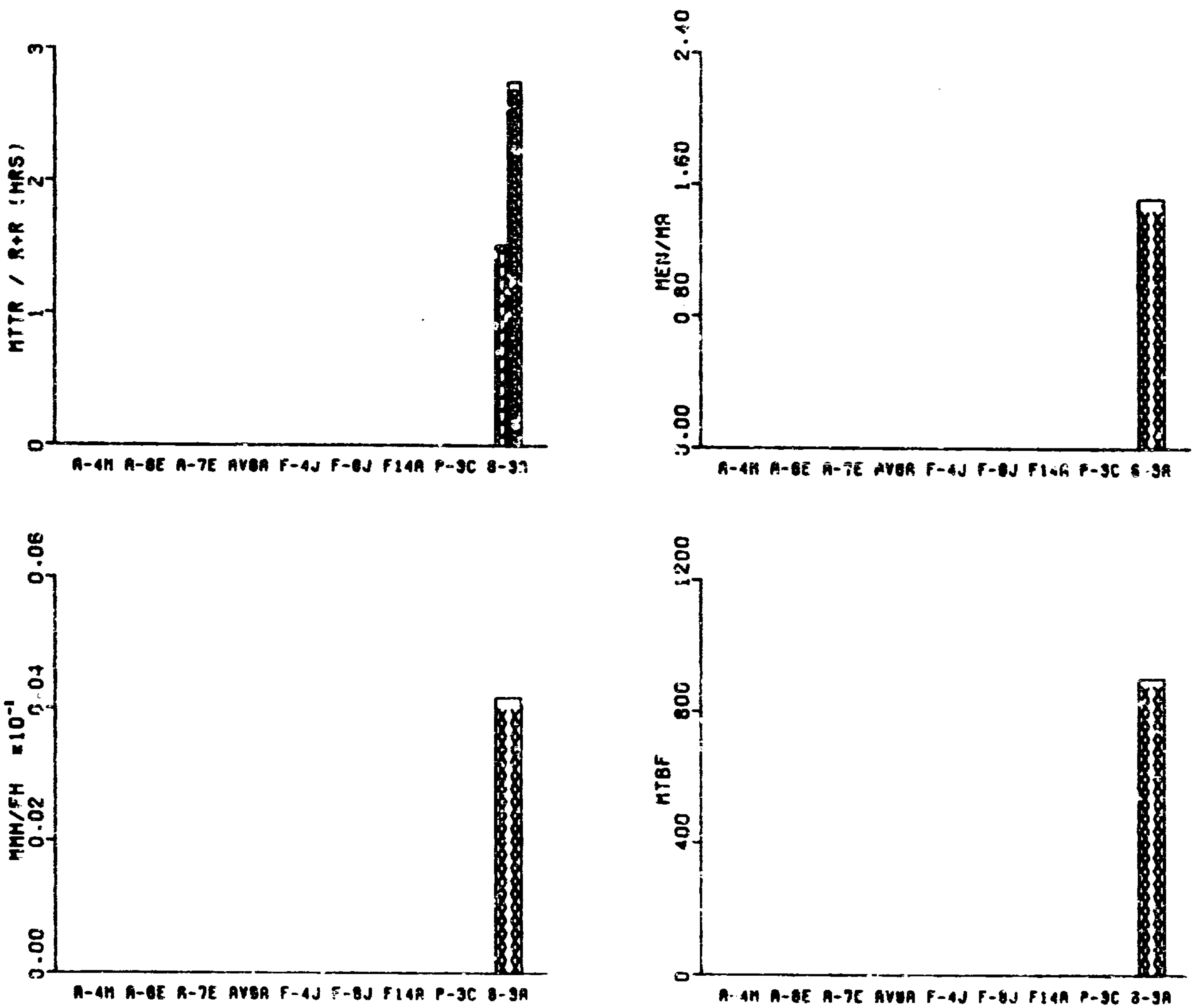


FIGURE 6.85 SELECTED GRAPHICAL DATA - IR POWER SUPPLY

6.16.3 IR Power Supply (See preceding Table and Figure 6.85)

WORK UNIT CODES

A-4 N/A	A-6 N/A	A-7 N/A	AV-8 N/A	F-4 N/A
F-8 N/A	F-14 N/A	P-3 N/A	S-3 77314	

DISCUSSION

Comments:

This item was surveyed on only one aircraft, consequently, no comparison relative to the quantitative aspects of the installation can be made. However, from a qualitative standpoint, the installation is excellent, utilizing rack and panel connectors and equipment lock lugs to secure the unit. The majority of the time reflected in the R+R average is spent accomplishing the after installation checkout.

Recommendations:

Require that BIT/BITE provisions be included in all component/systems design, and that they be comprehensive enough to eliminate, to the maximum extent possible, the need for follow-on operational/functional checks, including integrated systems checks.

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APPENDIX A

STANDARD WORK UNIT CODE (SWUC)
SUMMARY REPORT

NAVY FIGHTER/ATTACK/ASW AIRCRAFT STANDARD WORK UNIT CODE REPORT

TABLE A-1 CLASSIFICATION OF A-4M CLASS 1 DATA BY 2 DIGIT SWUC

SYSTEM	STD WUC	**** ORGANIZATIONAL LEVEL MA/FH	EMT/MA	MMH/MA	**** MMH/FH	***** INTERMEDIATE LEVEL MA/FH	EMT/MA	MMH/MA	***** MMH/FH	TOTAL MMH/FH
AIRFRAME	11	.066	2.670	5.300	.350	.004	5.040	4.650	.020	.370
FUSELAGE	12	.015	2.090	3.330	.050	.001	1.300	3.200	.002	.052
LANDING GEAR	13	.154	1.550	3.310	.510	.086	2.170	3.960	.343	.853
FLIGHT CONTROLS	14	.065	2.310	4.180	.272	.006	2.060	2.690	.017	.291
ENGINE	23	.054	3.290	9.390	.510	.028	3.160	8.260	.228	.738
AUXILLARY POWER PLANT	24	.037	2.500	4.700	.173	.005	4.030	6.500	.030	.203
POWER PLANT INSTALLAION	29	.017	2.750	4.820	.084	.005	1.500	1.500	.006	.090
AIR CONDITIONING	41	.019	1.820	2.670	.051	.002	2.390	2.960	.007	.058
ELECTRICAL	42	.072	2.500	4.720	.339	.009	2.310	3.100	.028	.367
LIGHTING	44	.065	1.130	1.860	.122	.016	3.490	4.850	.079	.201
HYDRAULIC	45	.018	2.540	4.700	.085	.002	2.340	3.760	.009	.094
FUEL	46	.034	2.810	4.290	.146	.003	.330	.334	.001	.147
OXYGEN	47	.016	1.220	1.620	.026	.006	7.730	9.890	.054	.080
MISCELLANEOUS UTILITIES	49	.001	1.960	3.570	.005	-	12.500	12.500	.003	.008
INSTRUMENTS	51	.057	1.930	3.680	.210	.015	1.120	1.730	.026	.236
FLIGHT REFERENCE	56	.009	2.570	4.980	.045	.003	1.170	1.400	.005	.050
INTEG GUIDANCE/FLIGHT CONTROL	57	.011	2.810	5.110	.056	.004	3.040	5.290	.020	.076
COMMUNICATIONS	60	.068	1.580	2.820	.132	.025	4.860	6.160	.154	.346
RADIO NAVIGATION	71	.026	1.600	2.009	.075	.015	2.660	4.010	.061	.136
RADAR NAVIGATION	72	.025	1.670	3.080	.076	.015	7.100	8.110	.121	.197
BOMBING NAVIGATION	73	.057	2.750	5.470	.311	.023	3.200	4.980	.115	.426
WEAPONS CONTROL	74	.038	1.950	3.620	.137	.016	2.100	3.350	.032	.169
WEAPONS DELIVERY	75	.052	1.790	3.180	.166	.013	6.150	12.750	.175	.341
ECM	76	.012	2.369	5.080	.062	.004	7.850	8.940	.044	.132
PHOTO	77	-	-	-	-	-	-	-	-	-
MISCELLANEOUS EQUIP/ SYSTEMS	90	.027	1.440	2.330	.063	.002	5.100	8.500	.017	.080
TOTAL UNSCHEDULED		1.000	2.070	4.040	4.122	.303	3.390	5.240	1.594	5.716
TURNAROUND/PREFLIGHT	03C	.591	-	1.000	.593	-	-	-	-	.593
DAILY/SPECIAL (D,M)	03D	1.383	-	1.040	1.445	.001	-	1.000	.002	1.447
PHASE (G,P,O)	03G	.021	-	30.710	.645	.054	-	1.030	.056	.701
CONDITIONAL	03S	.017	-	2.760	.047	.001	-	9.000	.009	.056
OTHER (HEARTFLUR)	03Z	.165	-	2.210	.375	.003	-	34.330	.103	.478
TOTAL INSPECTIONS		2.177	-	1.420	3.105	.059	-	2.600	.170	3.275
OPERATIONAL SUPPORT	01	3.057	-	1.210	3.705	.002	-	2.300	.007	3.712
CLEANING	02	.029	-	1.030	.030	.044	-	1.000	.044	.074
CORROSION PREVENTION	04	.076	-	2.510	.191	.011	-	2.510	.032	.223
SHOP SUPPORT	05	.350	-	3.300	1.156	.153	-	4.200	.659	1.811
TOTAL SUPPORT		3.512	-	1.450	5.082	.210	-	3.510	.738	5.820
TOTAL AIRCRAFT		6.689	-	1.840	12.309	.572	-	4.370	2.502	14.811

NAVY FIGHTER/ATTACK/ASW AIRCRAFT STANDARD WORK UNIT CODE REPORT

TABLE A-2 CLASSIFICATION OF A-6E CLASS 1 DATA BY 2 DIGIT SWUC

SYSTEM	STD WUC	**** ORGANIZATIONAL LEVEL **** MA/FH	ENT/MA	MMH/MA	MMH/FH	***** INTERMEDIATE LEVEL ***** MA/FH	ENT/MA	MMH/MA	MMH/FH	TOTAL MMH/FH
AIRFRAME	11	.255	[illegible]	3.570	.911	.005	5.210	8.000	.040	.951
FUSELAGE	12	.028	[illegible]	3.460	.100	.001	2.640	2.790	.003	.103
LANDING GEAR	13	.147	2.220	5.040	.741	.050	2.070	4.420	.221	[illegible]
FLIGHT CONTROLS	14	.079	3.960	8.650	.680	.010	3.640	5.030	.049	.729
ENGINE	23	.044	4.520	11.670	.513	.015	6.110	12.370	.194	.707
AUXILLARY POWER PLANT	24	-	-	-	-	-	-	-	-	-
POWER PLANT INSTALLATON	29	.027	3.060	6.270	.169	.008	3.100	4.190	.035	.204
AIR CONDITIONING	41	.048	2.550	4.270	.205	.010	1.600	1.710	.017	.222
ELECTRICAL	42	.179	2.750	4.970	.890	.033	5.490	8.290	.277	1.167
LIGHTING	44	.072	1.230	1.790	.130	.006	4.510	4.970	.032	.162
HYDRAULIC	45	.041	3.840	6.800	.279	.006	3.250	3.530	.024	.303
FUEL	46	.061	2.370	4.580	.280	.008	1.340	1.490	.013	.293
OXYGEN	47	.021	1.240	1.600	.035	.006	3.360	4.570	.034	.069
MISCELLANEOUS UTILITIES	49	.007	2.590	4.750	.035	.001	7.900	8.600	.002	.037
INSTRUMENTS	51	.155	2.250	3.820	.593	.050	1.970	2.380	.119	.712
FLIGHT REFERENCE	56	.047	1.770	3.040	.143	.018	4.210	6.220	.112	.255
INTEG GUIDANCE/FLIGHT CONTROL	57	.025	1.730	3.130	.077	.007	8.270	13.280	.093	.170
COMMUNICATIONS	60	.162	1.460	2.330	.379	.062	5.610	7.300	.453	.832
RADIO NAVIGATION	71	.044	1.410	2.520	.111	.028	4.690	6.820	.191	.302
RADAR NAVIGATION	72	.219	1.680	3.180	.697	.100	6.440	10.170	1.017	1.714
BOMBING NAVIGATION	73	.220	2.460	5.040	1.109	.082	8.740	12.790	1.049	2.158
WEAPONS CONTROL	74	.047	1.460	2.800	.132	.011	6.960	9.770	.112	.244
WEAPONS DELIVERY	75	.029	1.390	2.850	.082	.009	3.800	3.570	.031	.113
ECM	76	.034	2.660	5.230	.180	.013	7.870	10.700	.142	.322
PHOTO	77	-	-	-	.001	-	-	-	-	.001
MISCELLANEOUS EQUIP/ SYSTEMS	90	.012	1.650	2.500	.030	.002	4.210	5.190	.012	.042
TOTAL UNSCHEDULED		2.000	2.200	4.260	8.517	.555	5.280	7.760	4.275	12.792
TURNAROUND/PREFLIGHT	03C	.600	-	2.690	1.615	-	-	-	-	1.615
DAILY/SPECIAL (D,M)	03D	.689	-	4.440	3.061	.002	-	10.000	.020	3.081
PHASE (G,P,O)	03G	.025	-	39.200	.980	.001	-	1.000	.001	.981
CONDITIONAL	03S	.119	-	4.010	.478	-	-	-	-	.478
OTHER (HEARTFLUB)	03Z	.082	-	3.670	.301	.012	-	11.750	.141	.442
TOTAL INSPECTIONS		1.515	-	4.250	6.435	.015	-	10.800	.162	6.597
OPERATIONAL SUPPORT	01	3.754	-	2.130	8.012	.042	-	1.450	.061	8.073
CLEANING	02	.106	-	1.220	.129	.003	-	5.000	.015	.144
CORROSION PREVENTION	04	.193	-	5.540	1.069	.040	-	2.050	.082	1.151
SHOP SUPPORT	05	.327	-	1.860	.608	.193	-	1.990	.384	.992
TOTAL SUPPORT		4.380	-	2.240	9.818	.278	-	1.950	.542	10.360
TOTAL AIRCRAFT		7.835	-	3.130	24.760	.848	-	5.870	4.979	29.749

NAVY FIGHTER/ATTACK/ASW AIRCRAFT STANDARD WORK UNIT CODE REPORT

TABLE A-3 CLASSIFICATION OF A-7E CLASS 1 DATA BY 2 DIGIT SWUC

S Y S T E M	STD WUC	**** ORGANIZATIONAL LEVEL **** MA/FH	EMT/MA	MMH/MA	MMH/FH ****	***** INTERMEDIATE LEVEL ***** MA/FH	EMT/MA	MMH/MA	MMH/FH *****	TOTAL MMH/FH
AIRFRAME	11	.194	2.520	5.130	.995	.005	17.220	28.000	.146	1.141
FUSELAGE	12	.039	1.540	2.500	.076	.002	2.540	2.950	.005	.082
LANDING GEAR	13	.177	1.360	3.000	.667	.073	2.300	3.170	.222	.889
FLIGHT CONTROLS	14	.066	3.420	6.950	.458	.010	5.730	6.580	.068	.527
ENGINE	23	.036	7.590	23.960	.854	.048	3.950	11.290	.561	1.415
AUXILLARY POWER PLANT	24	-	-	-	-	-	-	-	-	-
POWER PLANT INSTALLAION	29	.028	2.060	4.150	.117	.005	2.230	2.430	.011	.128
AIR CONDITIONING	41	.032	2.790	4.610	.146	.011	2.446	2.600	.028	.173
ELECTRICAL	42	.046	3.550	7.250	.332	.010	3.380	4.010	.042	.374
LIGHTING	44	.054	1.330	2.070	.113	.007	4.280	4.590	.031	.144
HYDRAULIC	45	.040	2.030	3.660	.146	.018	2.088	2.220	.039	.185
FUEL	46	.026	3.330	7.560	.196	.004	2.940	5.220	.022	.218
OXYGEN	47	.014	1.280	1.750	.024	.004	4.390	4.660	.021	.045
MISCELLANEOUS UTILITIES	49	.006	2.310	4.090	.022	.002	2.900	3.350	.006	.028
INSTRUMENTS	51	.089	2.420	4.620	.412	.027	1.478	1.600	.043	.455
FLIGHT REFERENCE	56	.056	1.680	2.860	.159	.022	4.320	5.000	.108	.267
INTEG GUIDANCE/FLIGHT CONTROL	57	.052	2.320	4.620	.241	.020	4.500	5.000	.098	.339
COMMUNICATIONS	60	.107	1.320	2.390	.256	.040	4.330	5.280	.211	.467
RADIO NAVIGATION	71	.063	1.710	3.210	.202	.036	3.780	4.400	.159	.361
RADAR NAVIGATION	72	.082	1.610	3.640	.240	.049	3.270	4.490	.219	.467
BOMBING NAVIGATION	73	.155	2.050	4.250	.660	.062	6.690	10.520	.654	1.314
WEAPONS CONTROL	74	.104	1.920	3.890	.405	.037	5.810	7.890	.290	.695
WEAPONS DELIVERY	75	.075	1.850	3.670	.273	.036	4.230	4.840	.175	.448
ECM	76	.032	2.060	3.870	.125	.012	7.570	11.320	.136	.261
PHOTO	77	.002	1.740	2.830	.005	0.000	3.390	3.460	.001	.006
MISCELLANEOUS EQUIP/ SYSTEMS	90	.014	1.710	2.260	.033	.001	2.270	2.443	.002	.035
TOTAL UNSCHEDULED		1.590	2.200	4.520	7.180	.535	4.570	6.160	3.297	10.477
TURNAROUND/PREFLIGHT	03C	.554	-	1.370	.756	.001	-	.570	0.000	.755
DAILY/SPECIAL (D,M)	03D	.502	-	3.770	1.894	.003	-	.270	.001	1.895
PHASE (G,P,Q)	03G	.022	-	28.000	.621	0.000	-	0.000	0.000	.621
CONDITIONAL	03S	.083	-	3.220	.268	0.000	-	0.000	0.000	.268
OTHER (HEARTFLUB)	037	.089	-	2.750	.245	.003	-	.000	.001	.246
TOTAL INSPECTIONS		1.250	-	3.030	3.784	.007	-	.630	.004	3.788
OPERATIONAL SUPPORT	01	4.400	-	1.840	8.076	.005	-	1.540	.008	8.084
CLEANING	02	.073	-	2.950	.216	.005	-	1.050	.005	.221
CORROSION PREVENTION	04	.321	-	5.360	1.722	.048	-	.630	.030	1.752
SHOP SUPPORT	05	.364	-	1.660	.606	.091	-	.890	.090	.696
TOTAL SUPPORT		5.158	-	2.060	10.620	.149	-	.890	.133	10.754
TOTAL AIRCRAFT		7.998	-	2.700	21.584	.691	-	4.970	3.434	25.018

NAVY FIGHTER/ATTACK/ASW AIRCRAFT STANDARD WORK UNIT CODE REPORT

TABLE A-4 CLASSIFICATION OF AV3A CLASS 1 DATA BY 2 DIGIT SWUC

SYSTEM	STD WUC	ORGANIZATIONAL LEVEL MA/FH	EMT/MA	MMH/MA	MMH/FH	INTERMEDIATE LEVEL MA/FH	EMT/MA	MMH/MA	MMH/FH	TOTAL MMH/FH
AIRFRAME	11	.109	2.510	5.830	.639	.001	1.940	3.320	.003	.633
FUSELAGE	12	.017	3.688	6.530	.111	.002	.500	.660	.002	.113
LANDING GEAR	13	.156	2.160	4.210	.657	.091	2.430	4.530	.410	1.057
FLIGHT CONTROLS	14	.076	3.710	6.870	.523	.011	2.980	4.200	.046	.569
ENGINE	23	.045	3.890	13.070	.594	.005	5.220	17.660	.094	.688
AUXILLARY POWER PLANT	24	.029	3.560	7.300	.214	.010	4.950	6.440	.064	.278
POWER PLANT INSTALLATION	29	.051	2.270	4.136	.211	.008	5.060	7.500	.060	.271
AIR CONDITIONING	41	.023	3.440	5.640	.128	.005	2.400	3.200	.016	.144
ELECTRICAL	42	.208	1.630	2.850	.596	.047	5.240	8.420	.400	.995
LIGHTING	44	.041	1.310	1.790	.074	.006	2.420	3.350	.029	.096
HYDRAULIC	45	.038	3.360	6.340	.233	.006	2.440	4.160	.025	.268
FUEL	46	.072	3.290	6.220	.449	.013	1.870	2.100	.026	.475
OXYGEN	47	.026	1.610	2.270	.059	.007	7.370	7.600	.055	.114
MISCELLANEOUS UTILITIES	49	.001	3.730	0.470	.004	.001	1.650	2.600	.001	.005
INSTRUMENTS	51	.107	2.220	4.210	.451	.025	1.390	1.800	.045	.496
FLIGHT REFERENCE	56	.021	1.790	3.190	.067	.008	10.160	13.950	.112	.179
INTEG GUIDANCE/FLIGHT CONTROL	57	.032	2.420	4.330	.139	.010	4.670	6.630	.064	.203
COMMUNICATIONS	68	.082	1.630	2.856	.234	.023	5.270	7.080	.163	.397
RADIO NAVIGATION	71	.038	1.720	3.100	.120	.017	3.150	10.650	.179	.299
RADAR NAVIGATION	72	.018	2.510	4.420	.079	.005	.550	.600	.003	.082
BOMBING NAVIGATION	73	.135	2.070	4.020	.542	.044	5.450	8.200	.364	.906
WEAPONS CONTROL	74	.012	1.440	2.970	.037	.002	3.010	5.630	.011	.046
WEAPONS DELIVERY	75	.025	2.890	5.590	.139	.007	1.260	3.100	.023	.162
ECM	76	-	-	-	-	-	-	-	-	-
PHOTO	77	.004	2.170	4.220	.018	-	-	-	-	.018
MISCELLANEOUS EQUIP/ SYSTEMS	98	.007	3.600	6.670	.046	-	6.500	6.500	.002	.048
TOTAL UNSCHEDULED		1.383	2.430	4.640	6.419	.357	3.760	6.170	2.191	8.610
TURNAROUND/PREFLIGHT	03C	.641	-	1.280	.826	-	-	-	-	.826
DAILY/SPECIAL (D,M)	03D	1.110	-	2.160	2.397	-	-	-	-	2.397
PHASE (G,P,Q)	03G	.036	-	25.380	.914	.001	-	14.000	.014	.928
CONDITIONAL	03S	.026	-	9.800	.257	.002	-	1.000	.002	.259
OTHER (HEARTFLUR)	037	.100	-	7.100	.710	.008	-	9.100	.073	.783
TOTAL INSPECTIONS		1.913	-	2.660	5.104	.011	-	8.090	.089	5.193
OPERATIONAL SUPPORT	01	3.587	-	1.530	5.511	.005	-	2.400	.012	5.523
CLEANING	02	.234	-	.800	.188	.011	-	1.360	.015	.203
CORROSION PREVENTION	04	.192	-	6.710	1.290	.007	-	2.140	.015	1.305
SHOP SUPPORT	05	1.006	-	1.760	1.772	.287	-	1.810	.519	2.291
TOTAL SUPPORT		5.019	-	1.750	8.761	.310	-	1.810	.561	9.322
TOTAL AIRCRAFT		8.315	-	2.440	20.284	.678	-	4.190	2.041	23.125

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TABLE A-5 CLASSIFICATION OF F-4J CLASS 1 DATA BY 2 DIGIT SWUC

SYSTEM	STD WUC	**** ORGANIZATIONAL LEVEL **** MA/FH	EMT/MA	MMH/MA	MMH/FH	***** INTERMEDIATE LEVEL ***** MA/FH	EMT/MA	MMH/MA	MMH/FH	TOTAL MMH/FH
AIRFRAME	11	.266	3.080	5.560	1.592	.004	5.360	9.890	.040	1.632
FUSELAGE	12	.055	5.260	8.800	.483	.002	1.650	1.500	.004	.487
LANDING GEAR	13	.227	2.070	4.170	.944	.119	2.400	4.100	.500	1.444
FLIGHT CONTROLS	14	.154	3.890	7.700	1.199	.016	4.700	[illegible].070	.110	1.309
ENGINE	23	.057	6.150	15.990	.913	.027	5.500	13.100	.352	1.265
AUXILLARY POWER PLANT	24	-	-	-	-	-	-	-	-	-
POWER PLANT INSTALLAION	29	.033	3.460	7.330	.244	.005	2.960	3.710	.020	.264
AIR CONDITIONING	41	.062	4.380	8.080	.499	.011	1.190	1.430	.016	.515
ELECTRICAL	42	.075	4.360	8.510	.636	.020	4.160	6.400	.128	.764
LIGHTING	44	.105	1.470	2.390	.251	.002	3.030	4.690	.008	.259
HYDRAULIC	45	.060	4.340	8.642	.518	.012	3.130	3.890	.046	.564
FUEL	46	.058	5.610	13.270	.770	.009	2.340	3.030	.027	.797
OXYGEN	47	.028	.940	1.200	.034	.006	4.930	5.750	.038	.072
MISCELLANEOUS UTILITIES	49	.018	4.450	9.560	.168	.002	1.090	2.020	.004	.172
INSTRUMENTS	51	.106	2.340	4.440	.471	.026	1.340	1.700	.045	.516
FLIGHT REFERENCE	56	.103	2.530	4.720	.487	.052	5.540	7.700	.403	.890
INTEG GUIDANCE/FLIGHT CONTROL	57	.040	3.310	7.400	.299	.013	6.970	9.450	.128	.427
COMMUNICATIONS	60	.186	1.780	2.930	.546	.085	5.290	6.250	.531	1.077
RADIO NAVIGATION	71	.077	1.580	2.630	.203	.049	4.310	5.360	.263	.466
RADAR NAVIGATION	72	.044	1.840	3.280	.146	.030	3.400	4.170	.125	.271
BOMBING NAVIGATION	73	.059	2.440	4.310	.256	.029	3.070	4.990	.147	.403
WEAPONS CONTROL	74	.454	2.930	6.160	2.821	.244	4.500	6.860	1.679	4.500
WEAPONS DELIVERY	75	.038	4.190	8.780	.331	.018	3.100	4.760	.085	.416
ECM	76	.039	3.170	6.360	.249	.011	7.110	11.460	.128	.377
PHOTO	77	0.000	2.690	5.200	.002	.001	3.110	4.410	.004	.006
MISCELLANEOUS EQUIP/ SYSTEMS	98	.024	1.530	5.000	.120	.006	2.436	2.830	.017	.137
TOTAL UNSCHEDULED		2.393	2.998	5.920	14.210	.001	4.119	6.040	4.049	19.059
TURNAROUND/PREFLIGHT	03C	1.069	-	1.340	1.420	-	-	-	-	1.420
DAILY/SPECIAL (D,M)	03D	.981	-	3.750	3.670	.001	-	3.000	.003	3.661
PHASE (G,P,Q)	03G	.024	-	44.290	1.063	.002	-	51.500	.103	1.166
CONDITIONAL	03S	.087	-	8.640	.752	.001	-	2.000	.002	.754
OTHER (HEAPTFLUB)	03Z	.107	-	5.210	.559	.009	-	6.550	.059	.618
TOTAL INSPECTIONS		2.268	-	3.380	7.480	.013	-	12.050	.168	7.647
OPERATIONAL SUPPORT	01	3.817	-	2.490	9.530	.020	-	3.350	.068	9.597
CLEANING	02	.159	-	1.998	.317	.008	-	2.120	.017	.334
CORROSION PREVENTION	04	.318	-	6.088	1.935	.028	-	1.820	.051	1.986
SHOP SUPPORT	05	.593	-	1.760	1.041	.094	-	1.160	1.036	2.077
TOTAL SUPPORT		4.884	-	2.630	12.023	.950	-	1.230	1.171	13.994
TOTAL AIRCRAFT		9.545	-	3.620	34.513	1.764	-	3.519	6.187	40.700

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TABLE A-6 CLASSIFICATION OF F-[illegible]J CLASS 1 DATA BY 2 DIGIT SWUC

SYSTEM	STD WUC	**** ORGANIZATIONAL LEVEL MA/FH	ENT/MA	MMH/MA	**** MMH/FH	***** INTERMEDIATE LEVEL MA/FH	ENT/MA	MMH/MA	***** MMH/FH	TOTAL MMH/FH
AIRFRAME	11	.213	3.150	6.730	1.434	.011	3.230	7.730	.082	1.516
FUSELAGE	12	.020	1.540	2.403	.065	.002	.050	1.000	.002	.067
LANDING GEAR	13	.238	1.880	3.510	.808	.125	1.960	2.930	.365	1.173
FLIGHT CONTROLS	14	.133	3.580	7.270	.967	.018	7.150	3.550	.172	1.139
ENGINE	23	.056	7.440	20.330	1.143	.020	4.500	10.460	.293	1.436
AUXILLARY POWER PLANT	24	-	-	-	-	-	-	-	-	-
POWER PLANT INSTALLAION	29	.067	1.940	3.410	.229	.015	3.370	4.620	.070	.299
AIR CONDITIONING	41	.062	2.920	4.770	.296	.019	1.100	1.210	.023	.319
ELECTRICAL	42	.123	4.290	8.100	1.001	.019	2.630	3.900	.075	1.076
LIGHTING	44	.093	1.330	1.830	.171	.008	3.610	5.150	.044	.215
HYDRAULIC	45	.081	2.570	4.320	.350	.018	3.670	3.930	.074	.424
FUEL	46	.055	3.700	7.070	.387	.007	1.210	1.340	.009	.396
OXYGEN	47	.015	2.390	3.130	.047	.004	1.200	1.250	.005	.052
MISCELLANEOUS UTILITIES	49	.004	4.150	9.500	.038	-	-	-	.001	.039
INSTRUMENTS	51	.164	2.140	3.540	.652	.068	1.610	1.970	.134	.786
FLIGHT REFERENCE	56	.038	1.440	2.470	.094	.016	2.370	2.940	.047	.141
INTEG GUIDANCE/FLIGHT CONTROL	57	.131	2.970	5.340	.707	.055	3.550	4.440	.243	.950
COMMUNICATIONS	6[illegible]	.169	2.303	2.670	.269	.046	3.500	4.240	.195	.464
RADIO NAVIGATION	71	.106	1.530	2.830	.301	.066	3.640	4.410	.290	.591
RADAR NAVIGATION	72	.036	1.330	2.400	.087	.029	1.900	2.250	.066	.153
BOMBING NAVIGATION	73	.006	1.840	3.990	.023	.003	10.510	11.530	.034	.057
WEAPONS CONTROL	74	.166	1.390	4.010	.670	.088	6.420	8.860	.778	1.448
WEAPONS DELIVERY	75	.037	1.760	4.070	.153	.040	.670	1.120	.045	.198
ECM	76	.067	2.610	5.260	.352	.046	7.110	8.920	.413	.765
PHOTO	77	.002	5.650	7.850	.014	-	-	-	-	.014
MISCELLANEOUS EQUIP/ SYSTEMS	90	.008	2.620	3.750	.030	.004	1.520	1.750	.007	.037
TOTAL UNSCHEDULED		2.000	2.570	5.080	10.378	.720	3.660	4.780	3.469	13.847
TURNAROUND/PREFLIGHT	03C	.550	-	1.230	.679	-	-	-	.001	.680
DAILY/SPECIAL (D,M)	03D	1.660	-	1.620	2.683	.004	-	2.750	.011	2.694
PHASE (G,P,Q)	03G	.022	-	78.220	1.721	-	-	-	.002	1.723
CONDITIONAL	035	.054	-	3.670	.213	-	-	-	-	.213
OTHER (HEARTFLUB)	037	.249	-	2.440	.607	-	-	-	.004	.611
TOTAL INSPECTIONS		2.539	-	2.330	5.903	.005	-	3.600	.018	5.921
OPERATIONAL SUPPORT	01	5.793	-	2.050	11.873	.009	-	1.000	.009	11.882
CLEANING	02	.076	-	3.850	.293	.028	-	.300	.006	.299
CORROSION PREVENTION	04	.297	-	5.180	1.534	.014	-	.710	.010	1.544
SHOP SUPPORT	05	.291	-	4.830	1.405	1.493	-	2.600	.390	1.795
TOTAL SUPPORT		6.457	-	2.340	15.109	1.536	-	2.700	.415	15.524
TOTAL AIRCRAFT		10.996	-	2.850	31.398	2.269	-	1.720	3.902	35.292

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TABLE A-7 CLASSIFICATION OF F14A CLASS 1 DATA BY 2 DIGIT SWUC

SYSTEM	STD WUC	**** ORGANIZATIONAL LEVEL **** MA/FH	EMT/MA	MMH/MA	MMH/FH	***** INTERMEDIATE LEVEL ***** MA/FH	EMT/MA	MMH/MA	MMH/FH	TOTAL MMH/FH
AIRFRAME	11	.300	2.720	5.730	1.720	.011	11.970	19.450	.214	1.934
FUSELAGE	12	.071	1.460	2.560	.182	.003	2.120	2.580	.007	.189
LANDING GEAR	13	.227	2.310	5.930	1.351	.080	3.090	6.170	.497	1.848
FLIGHT CONTROLS	14	.135	6.600	18.420	2.473	.022	4.060	6.630	.147	2.620
ENGINE	23	.125	6.920	20.830	2.591	.081	12.400	36.450	.988	3.579
AUXILLARY POWER PLANT	24	-	-	-	-	-	-	-	-	-
POWER PLANT INSTALLAION	29	.102	2.640	5.660	1.825	.041	5.510	4.069	.330	1.355
AIR CONDITIONING	41	.081	3.070	6.170	.500	.014	2.380	3.350	.047	.547
ELECTRICAL	42	.109	3.200	7.260	.765	.018	4.140	6.750	.125	.910
LIGHTING	44	.103	1.400	2.700	.279	.003	7.090	11.700	.035	.314
HYDRAULIC	45	.069	3.000	9.070	.625	.007	5.360	7.920	.057	.682
FUEL	46	.069	4.030	10.600	.734	.007	1.390	2.050	.015	.749
OXYGEN	47	.017	1.860	1.530	.026	.007	2.630	2.700	.020	.046
MISCELLANEOUS UTILITIES	49	.013	3.200	6.460	.084	.002	4.470	3.800	.008	.092
INSTRUMENTS	51	.133	2.700	5.920	.780	.041	4.390	5.450	.240	1.020
FLIGHT REFERENCE	56	.147	1.820	3.970	.580	.058	7.140	12.050	.786	1.294
INTEG GUIDANCE/FLIGHT CONTROL	57	.053	2.580	5.620	.299	.016	11.170	16.520	.270	.569
COMMUNICATIONS	63	.318	1.380	2.690	.858	.087	5.930	8.440	.732	1.591
RADIO NAVIGATION	71	.033	1.460	3.020	.101	.013	2.940	3.620	.049	.150
RADAR NAVIGATION	72	.017	1.650	3.410	.059	.005	1.930	2.220	.011	.070
BOMBING NAVIGATION	73	.076	1.300	2.990	.228	.035	9.030	15.080	.568	.748
WEAPONS CONTROL	74	.435	1.730	4.210	1.814	.196	6.950	11.170	2.180	3.994
WEAPONS DELIVERY	75	.162	2.890	5.930	.685	.017	2.660	4.910	.083	.680
ECM	76	.064	2.340	5.400	.555	.023	18.310	16.030	.397	.752
PHOTO	77	-	-	-	-	-	-	-	-	-
MISCELLANEOUS EQUIP/ SYSTEMS	98	.029	1.110	1.550	.045	.004	2.520	2.520	.010	.055
TOTAL UNSCHEDULED		2.924	2.610	6.230	18.160	.752	6.190	10.290	7.749	25.905
TURNAROUND/PREFLIGHT	03C	1.074	-	1.490	1.612	.001	-	1.600	.002	1.613
DAILY/SPECIAL (D,N)	03D	1.415	-	2.850	4.030	.003	-	12.730	.038	4.076
PHASE (G,P,O)	03G	.030	-	37.750	1.133	.002	-	99.080	.253	1.306
CONDITIONAL	03S	.235	-	2.690	.633	.002	-	4.300	.009	.641
OTHER (WEARIFLUB)	037	.067	-	15.950	1.069	.015	-	10.030	.150	1.219
TOTAL INSPECTIONS		2.821	-	3.010	8.485	.023	-	19.650	.452	8.937
OPERATIONAL SUPPORT	01	5.230	-	2.110	11.070	.505	-	.650	.302	11.457
CLEANING	02	.041	-	3.310	.136	.005	-	3.760	.019	.155
CORROSION PREVENTION	04	.512	-	6.470	3.314	.027	-	2.070	.056	3.370
SHOP SUPPORT	05	.170	-	5.540	.941	1.424	-	1.030	1.471	2.412
TOTAL SUPPORT		5.953	-	2.600	15.460	2.041	-	.940	1.920	17.394
TOTAL AIRCRAFT		11.698	-	3.600	42.106	2.014	-	3.600	10.120	52.236

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TABLE A-8 CLASSIFICATION OF S-3A CLASS 1 DATA BY 2 DIGIT SWUC

SYSTEM	STD WUC	**** ORGANIZATIONAL LEVEL **** MA/FH	EMT/MA	MMH/MA	MMH/FH	***** INTERMEDIATE LEVEL ***** MA/FH	EMT/MA	MMH/MA	MMH/FH	TOTAL MMH/FH
AIRFRAME	11	.188	2.160	3.950	.745	.010	3.320	4.740	.049	.794
FUSELAGE	12	.022	1.980	3.970	.089	.001	1.230	1.230	.001	.090
LANDING GEAR	13	.227	1.770	3.760	.856	.089	2.590	3.720	.333	1.189
FLIGHT CONTROLS	14	.130	4.480	8.850	1.152	.021	3.090	5.590	.118	1.270
ENGINE	23	.071	4.860	12.190	.862	.009	3.500	9.120	.077	.939
AUXILIARY POWER PLANT	24	.059	2.200	4.490	.265	.013	2.560	4.000	.052	.317
POWER PLANT INSTALLAION	29	.055	2.180	4.070	.224	.008	1.910	2.750	.022	.246
AIR CONDITIONING	41	.072	2.860	5.320	.383	.013	2.690	4.070	.053	.436
ELECTRICAL	42	.075	3.240	6.390	.477	.018	1.980	2.570	.047	.524
LIGHTING	44	.069	1.640	2.760	.191	.011	1.960	2.300	.027	.218
HYDRAULIC	45	.028	2.700	5.500	.156	.007	2.170	2.020	.015	.171
FUEL	46	.024	3.330	6.300	.152	.004	.560	.570	.002	.154
OXYGEN	47	.013	1.350	1.950	.025	.005	4.900	5.270	.025	.050
MISCELLANEOUS UTILITIES	49	.007	3.450	7.140	.050	.001	1.000	1.330	.001	.051
INSTRUMENTS	51	.101	1.410	3.720	.376	.028	.770	.930	.026	.402
FLIGHT REFERENCE	56	.046	1.860	3.040	.140	.014	5.250	9.000	.126	.266
INTEG GUIDANCE/FLIGHT CONTROL	57	.064	2.240	4.100	.262	.018	7.090	10.090	.181	.443
COMMUNICATIONS	60	.199	1.470	2.580	.513	.048	5.950	9.960	.478	.991
RADIO NAVIGATION	71	.067	1.600	2.840	.192	.024	3.730	6.640	.163	.355
RADAR NAVIGATION	72	.108	1.780	3.350	.367	.030	6.170	10.440	.315	.682
BOMBING NAVIGATION	73	.454	1.960	3.610	1.625	.147	6.300	10.550	1.556	3.181
WEAPONS CONTROL	74	.007	2.440	4.820	.036	.002	.780	.910	.002	.038
WEAPONS DELIVERY	75	.013	2.010	3.970	.053	.002	2.100	2.250	.004	.057
ECM	76	.021	2.170	4.140	.089	.005	3.350	6.620	.033	.122
PHOTO	77	.042	2.070	4.380	.183	.011	10.250	16.240	.189	.372
MISCELLANEOUS EQUIP/ SYSTEMS	98	.084	1.300	1.910	.161	.003	1.450	1.640	.006	.167
TOTAL UNSCHEDULED		2.500	2.730	4.290	9.764	.555	4.410	7.140	3.938	13.702
TURNAROUND/PREFLIGHT	03C	.757	-	1.870	1.417	.001	-	1.000	.001	1.418
DAILY/SPECIAL (D,M)	03D	.797	-	2.240	1.788	.001	-	1.000	.001	1.789
PHASE (G,P,Q)	03G	.023	-	14.820	.341	-	-	-	-	.341
CONDITIONAL	03S	.064	-	2.870	.184	-	-	-	-	.184
OTHER (HEARTFLUB)	03Z	.046	-	8.000	.367	.003	-	1.000	.003	.370
TOTAL INSPECTIONS		1.687	-	2.430	4.097	.005	-	1.000	.005	4.102
OPERATIONAL SUPPORT	01	4.950	-	1.607	7.938	.219	-	.590	.130	8.068
CLEANING	02	.047	-	4.213	.198	.008	-	2.750	.022	.220
CORROSION PREVENTION	04	.307	-	2.630	.808	.007	-	1.850	.013	.821
SHOP SUPPORT	05	.871	-	.960	.835	.147	-	1.870	.276	1.109
TOTAL SUPPORT		6.175	-	1.580	9.777	.381	-	1.150	.441	10.218
TOTAL AIRCRAFT		10.362	-	2.280	23.658	.941	-	4.660	4.384	28.042

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TABLE A-9 CLASSIFICATION OF A-4M CLASS 3 DATA BY 2 DIGIT SWUC

S Y S T E M	STD WUC	**** ORGANIZATIONAL LEVEL **** MA/FH	EMT/MA	MMH/MA	MMH/FH	***** INTERMEDIATE LEVEL ***** MA/FH	EMT/MA	MMH/MA	MMH/FH	TOTAL MMH/FH
AIRFRAME	11	.044	2.012	4.052	.178	.004	2.740	3.292	.013	.191
FUSELAGE	12	.010	1.397	2.515	.025	.001	1.460	2.470	.002	.026
LANDING GEAR	13	.134	1.045	2.150	.288	.086	1.564	2.764	.238	.526
FLIGHT CONTROLS	14	.050	1.469	2.712	.136	.006	1.499	1.925	.012	.147
ENGINE	23	.036	1.376	5.669	.204	.024	1.551	3.199	.077	.281
AUXILLARY POWER PLANT	24	.019	1.407	2.562	.049	.004	2.740	4.156	.017	.065
POWER PLANT INSTALLAION	29	.012	1.619	2.005	.034	.004	1.051	1.297	.005	.039
AIR CONDITIONING	41	.012	1.179	1.785	.021	.002	1.640	1.993	.004	.025
ELECTRICAL	42	.045	1.691	3.223	.145	.008	1.713	2.316	.019	.164
LIGHTING	44	[illegible]	.017	1.327	.074	.015	2.571	3.583	.053	.127
HYDRAULIC	45	.013	1.650	3.321	.043	.002	1.603	2.650	.005	.048
FUEL	46	.022	1.314	2.828	.062	.003	.356	.508	.002	.064
OXYGEN	47	.011	.085	1.037	.011	.005	4.553	5.130	.026	.037
MISCELLANEOUS UTILITIES	49	.001	1.438	2.730	.003	-	-	-	-	.003
INSTRUMENTS	51	.040	1.389	2.498	.100	.013	.823	1.253	.016	.115
FLIGHT REFERENCE	56	.005	1.493	3.866	.019	.003	.947	1.204	.004	.023
INTEG GUIDANCE/FLIGHT CONTROL	57	.007	2.087	3.889	.027	.003	2.149	3.677	.011	.038
COMMUNICATIONS	60	.039	1.107	2.040	.080	.019	4.117	5.014	.095	.175
RADIO NAVIGATION	71	.011	1.241	2.220	.024	.006	3.617	5.007	.030	.054
RADAR NAVIGATION	72	.013	1.133	2.104	.027	.010	6.599	7.280	.073	.100
BOMBING NAVIGATION	73	.031	1.841	3.868	.120	.015	2.858	4.262	.064	.184
WEAPONS CONTROL	74	.024	1.293	2.359	.057	.008	1.683	2.428	.019	.076
WEAPONS DELIVERY	75	.032	1.303	2.417	.077	.012	5.527	8.402	.102	.179
ECM	76	.007	1.733	3.976	.028	.004	5.404	5.996	.024	.052
PHOTO	77	-	-	-	-	-	-	-	-	-
MISCELLANEOUS EQUIP/ SYSTEMS	90	.015	1.081	2.052	.031	.002	3.318	4.081	.008	.039
TOTAL UNSCHEDULED		.714	1.355	2.689	1.920	.263	2.402	3.510	.923	2.843
TURNAROUND/PREFLIGHT	03C	.591	-	.670	.396	-	-	-	-	.396
DAILY/SPECIAL (D,M)	03D	1.383	-	.697	.964	.001	-	.670	.001	.964
PHASE (G,P,Q)	03G	.021	-	20.576	.432	.054	-	.690	.037	.469
CONDITIONAL	03S	.017	-	1.849	.031	.001	-	6.030	.006	.037
TOTAL INSPECTIONS		2.012	-	.905	1.820	.056	-	.804	.045	1.865
SERVICING	012	1.810	-	.638	.636	-	-	-	-	.636
TROUBLESHOOT LAUNCH A/C	016	.576	-	.469	.270	-	-	-	-	.270
CORROSION PREVENTION	04	.076	-	1.682	.128	.011	-	1.958	.021	.149
TOTAL SUPPORT		1.662	-	.623	1.036	.011	-	1.958	.021	1.057
TOTAL AIRCRAFT		4.388	-	1.088	4.776	.333	-	2.[illegible]97	[illegible]	5.765

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TABLE A-10 CLASSIFICATION OF A-6E CLASS 3 DATA BY 2 DIGIT SWUC

SYSTEM	STD WUC	**** ORGANIZATIONAL LEVEL MA/FH	ENT/MA	MMH/MA	**** MMH/FH	***** INTERMEDIATE LEVEL MA/FH	ENT/MA	MMH/MA	***** MMH/FH	TOTAL MMH/FH
AIRFRAME	11	.207	1.293	2.457	.509	.005	3.669	5.158	.026	.534
FUSELAGE	12	.019	1.314	2.388	.045	.001	1.002	2.012	.002	.047
LANDING GEAR	13	.115	1.358	3.188	.367	.048	2.050	3.074	.148	.514
FLIGHT CONTROLS	14	.057	2.306	5.460	.311	.008	2.623	3.510	.028	.339
ENGINE	23	.027	2.792	7.837	.212	.013	3.604	6.690	.087	.299
AUXILLARY POWER PLANT	24	-	-	-	-	-	-	-	-	-
POWER PLANT INSTALLAION	29	.019	1.955	4.312	.082	.007	2.337	3.031	.021	.103
AIR CONDITIONING	41	.030	1.712	3.402	.102	.009	1.096	1.334	.012	.114
ELECTRICAL	42	.113	1.789	3.362	.380	.023	3.909	5.260	.121	.501
LIGHTING	44	.059	.864	1.275	.075	.005	3.201	3.522	.018	.093
HYDRAULIC	45	.029	2.317	4.794	.139	.006	1.707	2.223	.013	.152
FUEL	46	.040	1.593	3.205	.128	.008	1.010	1.190	.010	.138
OXYGEN	47	.015	.669	1.223	.018	.006	2.201	2.782	.016	.035
MISCELLANEOUS UTILITIES	49	.005	1.601	3.095	.015	.001	2.201	2.546	.003	.018
INSTRUMENTS	51	.088	1.577	2.933	.256	.070	1.272	1.038	.074	.332
FLIGHT REFERENCE	56	.024	1.169	2.127	.051	.015	3.175	4.485	.067	.118
INTEG GUIDANCE/FLIGHT CONTROL	57	.016	1.154	2.202	.035	.005	7.249	11.135	.056	.091
COMMUNICATIONS	60	.100	.936	1.623	.162	.049	4.527	5.654	.277	.439
RADIO NAVIGATION	71	.028	.952	1.750	.049	.020	4.005	5.772	.115	.164
RADAR NAVIGATION	72	.121	1.143	2.214	.268	.075	5.200	8.109	.608	.876
BOMBING NAVIGATION	73	.103	1.764	3.808	.392	.062	6.078	9.786	.602	.994
WEAPONS CONTROL	74	.032	.978	1.831	.059	.010	4.442	6.041	.068	.127
WEAPONS DELIVERY	75	.016	.993	2.046	.037	.008	2.051	2.453	.020	.056
ECM	76	.022	1.541	3.205	.071	.011	5.469	7.966	.088	.158
PHOTO	77	-	-	-	-	-	-	-	-	-
MISCELLANEOUS EQUIP/ SYSTEMS	90	.007	1.686	2.617	.014	.002	2.488	2.934	.006	.020
TOTAL UNSCHEDULED		1.294	1.443	2.915	3.773	.448	3.929	5.560	2.491	6.264
TURNAROUND/PREFLIGHT	03C	.600	-	1.802	1.081	-	-	-	-	1.081
DAILY/SPECIAL (D,M)	03D	.689	-	2.975	2.050	.002	-	6.700	.013	2.063
PHASE (G,P,Q)	03G	.025	-	26.264	.657	.001	-	.678	.001	.657
CONDITIONAL	03S	.119	-	2.687	.320	-	-	-	-	.320
TOTAL INSPECTIONS		1.433	-	2.868	4.109	.003	-	4.690	.014	4.123
SERVICING	012	.655	-	1.045	.685	-	-	-	-	.685
TROUBLESHOOT LAUNCH A/C	016	.338	-	1.219	.412	-	-	-	-	.412
CORROSION PREVENTION	04	.193	-	3.712	.716	.040	-	1.374	.055	.771
TOTAL SUPPORT		1.186	-	1.528	1.812	.040	-	1.374	.055	1.867
TOTAL AIRCRAFT		3.914	-	2.477	9.694	.491	-	5.214	2.560	12.254

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TABLE A-11 CLASSIFICATION OF A-7E CLASS 3 DATA BY 2 DIGIT SWUC

SYSTEM	STD WUC	**** ORGANIZATIONAL LEVEL **** MA/FH	EMT/MA	MMH/MA	MMH/FH	***** INTERMEDIATE LEVEL ***** MA/FH	EMT/MA	MMH/MA	MMH/FH	TOTAL MMH/FH
AIRFRAME	11	.179	1.531	3.281	.587	.095	11.465	17.910	.090	.677
FUSELAGE	12	.021	1.154	1.826	.038	.001	1.063	2.354	.002	.041
LANDING GEAR	13	.150	1.148	2.376	.356	.068	1.648	2.279	.155	.511
FLIGHT CONTROLS	14	.051	2.084	4.498	.229	.009	3.656	4.610	.041	.271
ENGINE	23	.023	4.592	15.820	.364	.040	2.701	7.364	.294	.658
AUXILLARY POWER PLANT	24	-	-	-	-	-	-	-	-	-
POWER PLANT INSTALLAION	29	.022	1.314	2.765	.061	.004	1.668	1.001	.008	.068
AIR CONDITIONING	41	.023	1.676	2.991	.069	.009	1.765	1.901	.018	.087
ELECTRICAL	42	.035	2.100	4.579	.160	.008	2.649	3.166	.025	.185
LIGHTING	44	.045	.890	1.391	.063	.006	3.175	3.454	.021	.083
HYDRAULIC	45	.033	1.247	2.359	.078	.018	1.395	1.509	.029	.106
FUEL	46	.017	2.027	4.944	.084	.004	2.123	3.696	.015	.099
OXYGEN	47	.011	.474	1.217	.013	.004	3.156	3.360	.013	.027
MISCELLANEOUS UTILITIES	49	.004	1.366	2.533	.010	.002	2.090	2.420	.005	.015
INSTRUMENTS	51	.061	1.557	3.178	.193	.023	1.161	1.309	.030	.224
FLIGHT REFERENCE	56	.039	1.092	1.918	.075	.020	3.065	3.541	.071	.146
INTEG GUIDANCE/FLIGHT CONTROL	57	.036	1.474	3.159	.114	.015	3.401	3.851	.058	.171
COMMUNICATIONS	68	.071	.674	1.553	.110	.030	3.539	4.306	.132	.242
RADIO NAVIGATION	71	.040	1.112	2.127	.085	.028	2.948	3.478	.097	.182
RADAR NAVIGATION	72	.044	1.097	2.092	.092	.033	2.805	3.802	.125	.218
BOMBING NAVIGATION	73	.083	1.350	2.962	.261	.046	5.209	7.866	.362	.622
WEAPONS CONTROL	74	.064	1.340	2.776	.178	.032	4.189	5.536	.177	.355
WEAPONS DELIVERY	75	.056	1.159	2.289	.128	.030	3.162	3.572	.107	.235
ECM	76	.021	1.272	2.515	.053	.010	5.870	8.537	.085	.138
PHOTO	77	.001	1.092	1.826	.002	0.000	2.564	2.652	0.000	.002
MISCELLANEOUS EQUIP/ SYSTEMS	98	.012	1.128	1.565	.019	.001	1.920	2.136	.002	.021
TOTAL UNSCHEDULED		1.146	1.487	2.991	3.427	.464	3.200	4.237	1.966	5.393
TURNAROUND/PREFLIGHT	03C	.554	-	.918	.509	.001	-	.382	.000	.509
DAILY/SPECIAL (D,M)	03D	.502	-	2.526	1.260	.003	-	.181	.001	1.269
PHASE (G,P,Q)	03G	.022	-	19.350	.426	0.000	-	0.000	0.000	.426
CONDITIONAL	03S	.083	-	2.157	.179	0.000	-	0.000	0.000	.179
TOTAL INSPECTIONS		1.161	-	2.044	2.373	.004	-	.296	.001	2.373
SERVICING	012	.713	-	.972	.693	0.000	-	0.000	0.000	.693
TROUBLESHOOT LAUNCH A/C	016	.486	-	1.119	.544	-	-	-	-	.544
CORROSION PREVENTION	04	.321	-	3.591	1.153	.042	-	.422	.020	1.173
TOTAL SUPPORT		1.520	-	1.575	2.393	.048	-	.422	.020	2.414
TOTAL AIRCRAFT		3.827	-	[illegible]	[illegible]	[illegible]	-	[illegible]	[illegible]	[illegible]

NAVY FIGHTER/ATTACK/ASW AIRCRAFT STANDARD WORK UNIT CODE REPORT

TABLE A-12 CLASSIFICATION OF AV3A CLASS 3 DATA BY 2 DIGIT SWUC

S Y S T E M	STD WUC	**** ORGANIZATIONAL LEVEL MA/FH	EMT/MA	MMH/MA	**** MMH/FH	***** INTERMEDIATE LEVEL MA/FH	EMT/MA	MMH/MA	***** MMH/FH	TOTAL MMH/FH
AIRFRAME	11	.090	2.260	4.040	.364	.001	1.421	2.366	.002	.366
FUSELAGE	12	.010	2.937	5.994	.060	.002	.485	.837	.002	.062
LANDING GEAR	13	.132	1.345	2.724	.360	.089	1.739	3.112	.277	.637
FLIGHT CONTROLS	14	.042	2.586	5.263	.221	.010	2.155	2.975	.030	.251
ENGINE	23	.030	2.327	9.031	.271	.005	1.583	3.597	.018	.289
AUXILLARY POWER PLANT	24	.015	2.534	5.808	.087	.005	4.786	6.089	.030	.118
POWER PLANT INSTALLATON	29	.034	1.645	3.194	.109	.008	3.792	4.728	.038	.146
AIR CONDITIONING	41	.014	2.172	4.046	.057	.005	1.629	2.291	.011	.066
ELECTRICAL	42	.182	.962	1.455	.265	.039	3.136	4.448	.173	.438
LIGHTING	44	.033	.942	1.304	.043	.004	1.967	2.782	.011	.054
HYDRAULIC	45	.023	2.229	4.759	.109	.006	1.798	2.944	.018	.127
FUEL	46	.054	1.976	4.063	.219	.012	1.389	1.614	.019	.239
OXYGEN	47	.021	1.086	1.628	.034	.085	4.955	5.125	.025	.056
MISCELLANEOUS UTILITIES	49	.001	2.177	2.515	.003	-	-	-	-	.003
INSTRUMENTS	51	.073	1.350	2.602	.190	.021	1.051	1.390	.029	.219
FLIGHT REFERENCE	56	.013	1.169	2.243	.029	.007	7.769	10.309	.072	.101
INTEG GUIDANCE/FLIGHT CONTROL	57	.022	1.588	2.857	.063	.007	4.826	5.399	.038	.101
COMMUNICATIONS	60	.050	1.102	1.959	.098	.015	4.416	6.474	.097	.195
RADIO NAVIGATION	71	.017	1.303	2.434	.041	.008	3.136	4.572	.037	.078
RADAR NAVIGATION	72	.012	1.738	3.194	.038	.004	.492	.657	.003	.041
BOMBING NAVIGATION	73	.081	1.358	2.672	.216	.028	4.689	6.847	.192	.404
WEAPONS CONTROL	74	.007	1.086	2.359	.017	.002	2.233	4.063	.008	.025
WEAPONS DELIVERY	75	.018	1.686	4.075	.073	.003	1.161	1.987	.006	.079
ECM	76	-	-	-	-	-	-	-	-	-
PHOTO	77	.003	1.681	3.385	.010	-	-	-	-	.010
MISCELLANEOUS EQUIP/ SYSTEMS	90	.006	2.131	4.165	.025	-	-	-	-	.025
TOTAL UNSCHEDULED		.990	1.541	3.049	3.018	.290	2.694	3.969	1.151	4.169
TURNAROUND/PREFLIGHT	03C	.641	-	.858	.550	-	-	-	-	.550
DAILY/SPECIAL (D,M)	03D	1.110	-	1.447	1.606	-	-	-	-	1.606
PHASE (G,P,Q)	03G	.036	-	17.005	.612	.001	-	9.365	.009	.622
CONDITIONAL	03S	.026	-	6.620	.172	.002	-	.670	.001	.173
TOTAL INSPECTIONS		1.813	-	1.621	2.940	.003	-	3.571	.011	2.950
SERVICING	012	1.140	-	.663	.756	-	-	-	-	.756
TROUBLESHOOT LAUNCH A/C	016	.007	-	2.198	.015	-	-	-	-	.015
CORROSION PREVENTION	04	.192	-	4.496	.863	.007	-	1.434	.010	.873
TOTAL SUPPORT		1.333	-	1.219	1.633	.007	-	1.434	.010	1.643
TOTAL AIRCRAFT		4.142	-	1.833	7.591	.300	-	3.907	1.172	8.762

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TABLE A-13 CLASSIFICATION OF F-4J CLASS 3 DATA BY 2 DIGIT SWUC

SYSTEM	STD WUC	**** MA/FH	ORGANIZATIONAL LEVEL EMT/MA	MMH/MA	**** MMH/FH	***** MA/FH	INTERMEDIATE LEVEL EMT/MA	MMH/MA	***** MMH/FH	TOTAL MMH/FH
AIRFRAME	11	.244	1.983	3.640	.888	.004	2.987	6.518	.026	.914
FUSELAGE	12	.040	3.656	6.834	.273	.002	1.070	1.235	.002	.276
LANDING GEAR	13	.204	1.278	2.608	.532	.118	1.726	2.913	.344	.876
FLIGHT CONTROLS	14	.125	2.337	4.892	.612	.014	3.429	4.920	.069	.688
ENGINE	23	.035	3.997	10.799	.378	.017	3.585	8.705	.148	.526
AUXILLARY POWER PLANT	24	-	-	-	-	-	-	-	-	-
POWER PLANT INSTALLAION	29	.025	2.213	5.066	.127	.004	2.084	2.658	.011	.137
AIR CONDITIONING	41	.045	2.849	5.681	.256	.010	.895	1.117	.011	.267
ELECTRICAL	42	.052	2.663	5.628	.293	.014	3.281	4.678	.065	.358
LIGHTING	44	.087	.993	1.646	.143	.001	3.195	3.739	.004	.147
HYDRAULIC	45	.047	2.865	6.365	.299	.012	2.129	2.621	.031	.331
FUEL	46	.038	3.718	9.727	.370	.008	1.596	2.055	.016	.386
OXYGEN	47	.022	.714	.915	.020	.006	3.455	4.013	.024	.044
MISCELLANEOUS UTILITIES	49	.008	2.408	5.837	.040	.001	1.272	1.602	.002	.042
INSTRUMENTS	51	.077	1.448	3.078	.237	.022	.953	1.268	.028	.265
FLIGHT REFERENCE	56	.065	1.645	3.298	.214	.042	4.176	5.718	.240	.454
INTEG GUIDANCE/FLIGHT CONTROL	57	.027	2.058	4.434	.120	.011	4.793	6.499	.071	.191
COMMUNICATIONS	60	.115	1.218	2.214	.255	.065	4.286	5.032	.327	.582
RADIO NAVIGATION	71	.050	1.804	1.739	.087	.036	3.624	4.518	.162	.249
RADAR NAVIGATION	72	.026	1.216	2.226	.058	.017	3.195	3.771	.064	.122
BOMBING NAVIGATION	73	.032	1.614	2.985	.096	.019	3.279	4.100	.078	.173
WEAPONS CONTROL	74	.322	1.872	4.139	1.333	.192	3.585	5.293	1.016	2.349
WEAPONS DELIVERY	75	.023	3.289	7.460	.172	.014	2.168	3.124	.044	.215
ECM	76	.020	2.894	4.255	.085	.008	5.690	8.948	.072	.157
PHOTO	77	0.000	1.831	3.785	0.000	.001	2.897	3.000	.003	.003
MISCELLANEOUS EQUIP/ SYSTEMS	90	.020	2.451	3.443	.069	.005	1.728	2.291	.011	.080
TOTAL UNSCHEDULED		1.756	1.914	3.976	6.982	.655	3.117	4.440	2.913	9.896
TURNAROUND/PREFLIGHT	03C	1.069	-	.898	.960	-	-	-	-	.960
DAILY/SPECIAL (D,H)	03D	.981	-	2.513	2.465	.001	-	2.010	.002	2.467
PHASE (G,P,Q)	03G	.024	-	29.674	.712	.002	-	34.585	.069	.781
CONDITIONAL	03S	.087	-	5.789	.504	.001	-	1.340	.001	.565
TOTAL INSPECTIONS		2.161	-	2.144	4.633	.004	-	16.090	.072	4.706
SERVICING	012	1.208	-	.610	.737	.002	-	.676	.001	.738
TROUBLESHOOT LAUNCH A/C	016	.379	-	.697	.264	-	-	-	-	.264
CORROSION PREVENTION	04	.318	-	4.074	1.295	.020	-	1.219	.034	1.330
TOTAL SUPPORT		1.905	-	1.208	2.297	.030	-	1.186	.036	2.333
TOTAL AIRCRAFT		5.822	-	2.390	13.912	.689	-	4.335	3.021	16.935

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TABLE A-14 CLASSIFICATION OF F-8J CLASS 3 DATA BY 2 DIGIT SWUC

S Y S T E M	STD WUC	**** ORGANIZATIONAL MA/FH	LEVEL EMT/MA	MMH/MA	**** MMH/FH	***** INTERMEDIATE MA/FH	LEVEL EMT/MA	MMH/MA	***** MMH/FH	TOTAL MMH/FH
AIRFRAME	11	.191	1.924	4.394	.039	.013	3.266	4.175	.054	.093
FUSELAGE	12	.013	1.293	2.469	.032	.001	.640	.924	.001	.033
LANDING GEAR	13	.211	1.169	2.202	.465	.123	1.420	2.124	.261	.726
FLIGHT CONTROLS	14	.107	2.177	4.765	.510	.016	5.098	6.629	.106	.616
ENGINE	23	.041	4.100	11.733	.481	.021	2.954	6.510	.137	.618
AUXILLARY POWER PLANT	24	-	-	-	-	-	-	-	-	-
POWER PLANT INSTALLAICN	29	.035	1.226	2.220	.122	.012	2.407	3.340	.040	.162
AIR CONDITIONING	41	.045	1.857	3.373	.152	.017	.797	1.104	.019	.171
ELECTRICAL	42	.099	2.518	5.199	.515	.014	1.993	2.007	.039	.554
LIGHTING	44	.079	.926	1.304	.103	.007	2.010	3.963	.028	.131
HYDRAULIC	45	.066	1.593	2.840	.187	.017	2.577	2.776	.047	.235
FUEL	46	.039	2.441	5.118	.200	.006	.895	1.092	.007	.206
OXYGEN	47	.011	1.707	2.381	.025	.003	.979	1.129	.003	.029
MISCELLANEOUS UTILITIES	49	.004	2.384	4.255	.017	.001	1.330	1.546	.002	.019
INSTRUMENTS	51	.131	1.350	2.405	.315	.052	1.181	1.521	.079	.394
FLIGHT REFERENCE	56	.031	.947	1.652	.051	.014	1.004	2.124	.030	.081
INTEG GUIDANCE/FLIGHT CONTROL	57	.107	1.764	3.402	.364	.049	2.564	3.174	.156	.520
COMMUNICATIONS	60	.064	.962	1.681	.108	.031	3.136	3.808	.118	.226
RADIO NAVIGATION	71	.066	1.045	1.884	.124	.045	3.299	3.914	.176	.300
RADAR NAVIGATION	72	.018	.947	1.663	.030	.013	1.999	2.447	.032	.062
BOMBING NAVIGATION	73	.003	1.340	3.234	.010	.002	9.054	10.539	.021	.031
WEAPONS CONTROL	74	.112	1.241	2.718	.304	.062	5.560	7.450	.462	.756
WEAPONS DELIVERY	75	.028	1.247	2.892	.081	.030	.602	1.005	.038	.119
ECM	76	.049	1.567	3.286	.161	.037	5.612	6.847	.253	.414
PHOTO	77	.001	1.757	2.846	.003	-	-	-	-	.003
MISCELLANEOUS EQUIP/ SYSTEMS	90	.007	1.469	1.936	.014	.004	1.003	1.398	.006	.019
TOTAL UNSCHEDULED		1.666	1.614	3.298	5.494	.597	2.753	3.547	2.117	7.612
TURNAROUND/PREFLIGHT	03C	.550	-	.824	.453	-	-	-	-	.453
DAILY/SPECIAL (D,M)	030	1.660	-	1.085	1.802	.004	-	1.843	.007	1.809
PHASE (G,P,Q)	036	.022	-	52.407	1.153	-	-	-	-	1.153
CONDITIONAL	035	.058	-	2.459	.143	-	-	-	-	.143
TOTAL INSPECTIONS		2.290	-	1.548	3.544	.005	-	2.412	.012	3.556
SERVICING	012	1.461	-	.992	1.449	.005	-	.134	.001	1.449
TROUBLESHOOT LAUNCH A/C	C16	.801	-	.972	.778	.002	-	.678	.001	.780
CORROSION PREVENTION	64	.297	-	3.471	1.031	.014	-	.476	.007	1.037
TOTAL SUPPORT		2.559	-	1.273	3.258	.021	-	.442	.009	3.267
TOTAL AIRCRAFT		6.515	-	1.887	12.296	.623	-	3.432	2.138	14.435

NAVY FIGHTER/ATTACK/ASW AIRCRAFT STANDARD WORK UNIT CODE REPORT

TABLE A-15 CLASSIFICATION OF F14A CLASS 3 DATA BY 2 DIGIT SWUC

SYSTEM	STD WUC	**** ORGANIZATIONAL LEVEL **** MA/FH	EMT/MA	MMH/MA	MMH/FH	***** INTERMEDIATE LEVEL ***** MA/FH	EMT/MA	MMH/MA	MMH/FH	TOTAL MMH/FH
AIRFRAME	11	.219	1.748	3.907	.856	.010	7.700	11.415	.114	.970
FUSELAGE	12	.054	1.009	1.762	.095	.003	1.564	1.943	.006	.101
LANDING GEAR	13	.169	1.366	3.547	.599	.078	2.680	4.156	.324	.924
FLIGHT CONTROLS	14	.079	4.137	12.469	.985	.019	3.857	4.187	.080	1.965
ENGINE	23	.062	2.689	7.669	.475	.014	4.267	11.104	.155	.631
AUXILLARY POWER PLANT	24	-	-	-	-	-	-	-	-	-
POWER PLANT INSTALLAION	29	.038	5.486	2.011	.137	.032	4.143	5.747	.186	.381
AIR CONDITIONING	41	.054	1.965	4.156	.224	.013	1.635	2.291	.030	.254
ELECTRICAL	42	.069	2.118	5.112	.353	.012	3.214	4.027	.054	.411
LIGHTING	44	.090	.926	1.727	.155	.002	5.943	8.519	.017	.172
HYDRAULIC	45	.046	2.446	6.282	.285	.006	3.649	5.807	.030	.315
FUEL	46	.047	3.804	7.069	.333	.007	1.005	1.495	.010	.344
OXYGEN	47	.013	.761	1.101	.014	.006	1.900	2.000	.012	.027
MISCELLANEOUS UTILITIES	49	.007	2.327	5.744	.040	.001	1.668	4.107	.004	.044
INSTRUMENTS	51	.085	1.826	4.347	.370	.034	3.429	4.361	.148	.518
FLIGHT REFERENCE	56	.069	1.252	2.028	.195	.044	5.603	9.243	.432	.684
INTEG GUIDANCE/FLIGHT CONTROL	57	.023	1.841	4.631	.107	.011	9.510	13.565	.149	.256
COMMUNICATIONS	68	.186	.885	1.739	.323	.063	4.767	6.628	.430	.754
RADIO NAVIGATION	71	.013	.967	1.826	.024	.005	3.422	4.106	.021	.044
RADAR NAVIGATION	72	.009	1.128	2.336	.021	.004	1.492	1.794	.007	.028
BOMBING NAVIGATION	73	.032	.975	2.011	.064	.027	6.070	11.440	.309	.373
WEAPONS CONTROL	74	.196	1.257	3.889	.606	.126	6.223	9.669	1.169	1.766
WEAPONS DELIVERY	75	.037	1.221	3.107	.115	.010	2.196	3.485	.035	.152
ECM	76	.039	1.324	3.966	.128	.017	9.86[illegible]	14.119	.240	.368
PHOTO	77	-	-	-	-	-	-	-	-	-
MISCELLANEOUS EQUIP/ SYSTEMS	98	.017	.792	1.182	.020	.004	1.024	1.894	.008	.020
TOTAL UNSCHEDULED		1.756	1.619	3.449	6.030	.555	4.754	7.263	4.031	10.651
TURNAROUND/PREFLIGHT	03C	1.074	-	.998	1.072	.001	-	1.072	.001	1.073
DAILY/SPECIAL (D,M)	03D	1.415	-	1.918	2.782	.003	-	8.529	.026	2.728
PHASE (G,P,Q)	03G	.030	-	25.293	.759	.002	-	65.330	.133	.891
CONDITIONAL	03S	.235	-	1.002	.424	.002	-	2.001	.006	.429
TOTAL INSPECTIONS		2.754	-	1.802	4.964	.006	-	33.614	.202	5.165
SERVICING	012	1.190	-	.804	.957	.459	-	.335	.150	1.111
TROUBLESHOOT LAUNCH A/C	016	.860	-	1.360	1.170	.001	-	3.015	.003	1.175
CORROSION PREVENTION	04	.512	-	4.335	2.219	.027	-	1.307	.037	2.257
TOTAL SUPPORT		2.562	-	1.695	4.343	.487	-	.492	.196	4.539
TOTAL AIRCRAFT		7.072	-	2.282	16.137	1.048	-	4.276	4.429	20.565

NAVY FIGHTER/ATTACK/ASW AIRCRAFT STANDARD WORK UNIT CODE REPORT

TABLE A-16 CLASSIFICATION OF S-3A CLASS 3 DATA BY 2 DIGIT SWUC

S Y S T E M	STD WUC	**** ORGANIZATIONAL LEVEL MA/FH	EMT/MA	MMH/MA	**** MMH/FH	***** INTERMEDIATE LEVEL MA/FH	EMT/MA	MMH/MA	***** MMH/FH	TOTAL MMH/FH
AIRFRAME	11	.151	1.350	2.510	.379	.010	2.331	3.261	.033	.412
FUSELAGE	12	.015	1.402	3.031	.045	.001	.968	1.067	.001	.047
LANDING GEAR	13	.178	1.097	2.324	.414	.007	1.043	2.621	.228	.642
FLIGHT CONTROLS	14	.066	3.120	6.724	.444	.021	2.149	3.733	.078	.522
ENGINE	23	.040	2.756	7.292	.292	.008	2.480	5.594	.044	.336
AUXILLARY POWER PLANT	24	.032	1.459	3.165	.101	.011	1.733	2.504	.024	.130
POWER PLANT INSTALLAION	29	.032	1.500	2.968	.095	.008	1.389	2.136	.017	.112
AIR CONDITIONING	41	.025	2.332	5.020	.125	.008	.927	1.465	.012	.137
ELECTRICAL	42	.047	2.069	4.359	.205	.016	1.454	1.094	.030	.235
LIGHTING	44	.053	1.092	1.866	.099	.010	1.454	1.757	.018	.116
HYDRAULIC	45	.016	1.840	4.121	.066	.005	1.564	2.055	.010	.076
FUEL	46	.013	2.069	4.127	.054	.004	.531	.663	.003	.056
OXYGEN	47	.008	.947	1.373	.011	.004	3.528	3.783	.015	.026
MISCELLANEOUS UTILITIES	49	.006	1.355	3.443	.021	.001	.810	1.129	.001	.022
INSTRUMENTS	51	.053	1.306	2.689	.143	.028	.786	.856	.024	.166
FLIGHT REFERENCE	56	.022	1.159	2.011	.044	.013	3.552	5.989	.078	.122
INTEG GUIDANCE/FLIGHT CONTROL	57	.024	1.777	3.327	.080	.013	5.664	7.072	.102	.182
COMMUNICATIONS	60	.092	.947	1.652	.152	.038	4.481	7.369	.280	.432
RADIO NAVIGATION	71	.026	1.190	2.144	.056	.017	3.240	5.641	.096	.152
RADAR NAVIGATION	72	.054	1.236	2.399	.130	.026	4.481	7.363	.191	.321
BOMBING NAVIGATION	73	.208	1.319	2.521	.524	.123	4.540	7.419	.913	1.437
WEAPONS CONTROL	74	.003	1.893	4.121	.012	.002	.667	.668	.002	.014
WEAPONS DELIVERY	75	.010	1.092	2.617	.028	.001	1.668	1.038	.002	.022
ECM	76	.009	1.315	3.020	.027	.005	2.305	4.317	.022	.049
PHOTO	77	.017	1.572	3.599	.061	.010	7.704	11.738	.117	.179
MISCELLANEOUS EQUIP/ SYSTEMS	90	.046	.805	1.443	.066	.003	1.135	1.359	.004	.070
TOTAL UNSCHEDULED		1.250	1.453	2.933	3.666	.476	3.138	4.951	2.357	6.023
TURNAROUND/PREFLIGHT	03C	.757	-	1.253	.948	.001	-	.678	.001	.949
DAILY/SPECIAL (D,M)	03D	.797	-	1.501	1.196	.001	-	.678	.001	1.197
PHASE (G,P,Q)	03G	.023	-	9.929	.228	-	-	-	-	.228
CONDITIONAL	03S	.064	-	1.923	.123	-	-	-	-	.123
TOTAL INSPECTIONS		1.641	-	1.521	2.496	.002	-	.678	.001	2.497
SERVICING	012	.712	-	.710	.506	.212	-	.275	.058	.564
TROUBLESHOOT LAUNCH A/C	016	.873	-	1.159	1.012	-	-	-	-	1.012
CORROSION PREVENTION	04	.307	-	1.762	.541	.007	-	1.240	.009	.550
TOTAL SUPPORT		1.892	-	1.085	2.054	.219	-	.308	.067	2.121
TOTAL AIRCRAFT		4.783	-	1.718	8.216	.697	-	3.479	2.425	10.641

APPENDIX B

STANDARD WORK UNIT CODE (SWUC) MATRIX

TABLE B-1 SWUC MATRIX

SYSTEM	STD WUC	A-4M	A-6E	A-7E	AV-8A
AIRFRAME	11	11, (-1135)	11, (-11A)	11, 121, 498	11, 121
Structure	11A	110, 111, 112, 1132, 1141, 115	1111, 1114, 1116, 1117, 112, 113, 117, 118, 118, (-11216)	1111, 1112, 1115/6, 1121/3, 1131/3, 1141/3, 1144/6, 1151	1111, 1113, 1121, 1131, 1141, 1151, 1161
Access Doors/Panels	11B	1131, 1133	1113, 11216	1114, 1117/8, 1119/A, 1122, 1132/4, 1142, 1145, 1152	1112, 1122, 1123, 1133, 1134, 1142, 1152, 1162
Windshield	11C	1134	11121	1113	1124
Canopy	11D	1136, 1137, 1139	11122, 114	121	171
Wingfold	11E	N/A	119	498	N/A
FUSELAGE	12	12, 1135	12	12, (-121)	12, (-121)
Ejection Seat Instl	12A	121, 122, 123, 124	121, 123	122, 126	122
Cockpit Equip	12B	1135, 125	122	125, 124	123
LANDING GEAR	13	13, (-1351)	13, 11A	13, (-1343)	13
NLG and Doors	13A	1311, 1312, 1313 13411→13414, 13425→1342C, 13438→1343M	131, 11A	1311, 1312, 1321,	131
MLG and Doors	13B	1321, 1322 13415→13417 13421→13424 13431→13437	132	1314, 1315, 1322	132
Wheels/Tires	13C	1314, 1323	135	1313, 1316	135
Brake System	13D	1371	136	1351, 1352, 1355	137, 138
Steering System	13E	133	137	136	139
LDG Controls	13F		134, -1345	1341, 1342, 1344	136
Arresting Gear	13G	1382	138	138	N/A
Catapulting System	13H	1381	139	137	N/A
Emergency System	13J	136	1345	133, 1353, 1354	N/A
FLIGHT CONTROLS	14	14, (-148)	14	14, (-1478), (-1455)	14
Control Stick Assy	14A	141	142	141	144
Lateral Control System	14B	142, 14A, 14914	1411, 143, 149	142, 143	141
Longitudinal Control System	14C	143, 146, 1491A, 1491D	1413, 145, 14B	145, (-1455)	143
Directional Control System	14D	147, 1491C	1412, 144, 14A	144	142
Flaps/Slats	14E	145, 14917, 14918	1414, 146, 148, (-14143)	147, (-1478)	145
Speed Brake System	14F	144, 14915, 14916	14143, 147	146	146
Wing Sweep System	14G	N/A	N/A	N/A	N/A
ENGINE	23	23	23	23	27
Basic Engine	23A	2350, 2351, 2352, 2353 238	2350, 2351, 2352, 2353	23D0, 23D1, 23D2, 23D3, 23D4	2720, 2721, 2722, 2723, 2724
Accessory Drive System	23B	2355	2355	23D5	2725
Main Fuel System	23C	2356	2356	23D6	2726
Lubrication System	23D	2358	2358	23D8	2728
Electrical System	23E	2359	2359	23D9	2729
Ignition System	23F	235A	235A	23DA	272A
Bleed Air System	23G	235B	235B	23DB	272B
[illegible] POWER [illegible]	[illegible]	2952	N/A	N/A	[illegible]
POWER PLANT INSTL	29	29, (-2952)	29	29, (-298)	29, (-292)
Engine Mount/Suspension	29A	291	291	291	
Power Plant Controls	29B	293	293	293	291
Ignition Starting System	29C		295	295	
Exhaust System	29D	296	296	296	294
Approach Power Compensating	29E	29C	29C	29C	

TABLE B-2 SWUC MATRIX

SYSTEM	STD WUC	A-4M	A-6E	A-7E	AV-8A
AIR CONDITIONING	41	41,493	41,493	41,494	41,491
Air Conditioning	41A	411, 414, 415	411	411	411, 413
Pressurization	41B	412, 416	413	412	412, 414
Ice/Rain/Wash Control	41C	413, 493	412, 493	4132, 494	491
Boundary Layer Control	41D	N/A	N/A	N/A	N/A
ELECTRICAL	42	42	42, (-4242)	42	42
Generator Drive System	42A	4224, 4225	4214	421	4211, 4212
AC Power Supply	42B	4221, 423	4211, 423, 424, (-4242)	4221, 424	4213, 4214, 4215, 4216
DC Power Supply	42C	424	422	4222	422
Power Distribution System	42D	421	4212, 4215	423	424
Aircraft Wiring	42E	428	428	428	428
LIGHTING	44	44	44	44	44
Exterior Lighting	44A	441	441	441	442
Interior Lighting	44B	442	442	442	441, 443
HYDRAULIC	45	45, (-45141), (-45541)	45, (-4528)	45, (-4513, 4523, 4532)	45
Normal	45A	45, (-45141), (-45541)	4521, 4523	451, 452, 454, (-4513), (-4522)	451, 452
Emergency/Auxiliary	45B		4524, 4526	453, (-4532)	453
Pneumatic	45C			455	
FUEL	46	46, (-466)	46	46, (-466)	46
Internal Fuel System	46A	461, 462, 463, 465	4611, 462, 463, 464	461, 462, 463	4611, 4617, 462, [illegible]
External Fuel System	46B	464, 46A, 46C	4612	465, 46A, 46C	4618, 4619
Aerial Refueling System	46C	467	465, 466, 46A/B/C	464	464
OXYGEN	47	47, (-47114)	47	47	47
MISC. UTILITIES	49	49, (-493)	49, 4528, (-492/3)	49, 911, (-492/4)	49, (-491), (-493)
Fire Detection	49A	491	491	491	492
Flight Recorder System	49B	N/A	494	N/A	N/A
On-Aircraft Test Equipment	49C	N/A	N/A	N/A	N/A
Air Driven Turbine Systems	49D	N/A	4528, 4242	911	N/A
INSTRUMENTS	51	51, 1351, 148, 45141, 45541, 466, 47114	51, 492, (-5114)	51, 1343, 1455, 1479, 298, 4513, 4523, 4532, 466, (-5114)	51, (-5115), 493
Flight/Nav Instruments	51A	511, 513, 5141A, 5141B, 515	5111, 5112, 5113, 512, 513	51110, 51111, 51112, 51113, 51119, 5112, 5113, 5115, 5116, 5121	5111, 5113, 5114, [illegible]
Engine Instruments	51B	512	514	51114, 5111B, 5111D, 5111E, 5111F, 298	512
Fuel Quantity Indication	51C	51415, 466	517	5111A, 466	513
Position Indication (13,14)	51D	1351, 148	516	1343, 1455, 1479	514, 5112
Utility Indication (45,47)	51E	45141, 45541, 47114	515	5111B, 5111C, 4513, 4523, 4532	515
Advisory/Warning Indication	51F	514, (-51415)	492		493
FLIGHT REFERENCE	56	56	56, 5114	56, 5114, 73A6	56, 5115
Angle of Attack Indication	56A	56B	5114	5114	5115
Air Data Computer	56B	565	565A0	5629, 73A6	[illegible]
Attitude Heading & Reference	56C	56X	56X1, 568	5625, 56X1	
INTEG GUID/FLIGHT CONTROL	57	57	57	57	57
COMMUNICATIONS	60	6X	6X, (-67X16), (-67X19)	6X	6X
VHF Communication	62	62	N/A	N/A	62

TABLE B-3 SWUC MATRIX

SYSTEM	STD WUC	A-4M	A-6E	A-7E	AV-8A
UHF Comm.	63	63, (-6351)	63, 67X15, (-6351)	63, (-6351)	6[illegible]
Interphone	64	64	64	64	N/A
IFF	65	65	65, 67X18	65	6[illegible]
Emergency Radio	66	66	66	66	66
CNI	67	67	67, (-67X14), (-67X15), (-67X16), (-67X18)	67	67, (-67[illegible])
Misc. Comm.	69	6351	69, 6351	69, 6951	6[illegible]
RADIO NAVIGATION	71	71	71, 67X16, 67X18	71	71
Direction Finder Group/Set	71A	7116	7116	7116	N/A
TACAN Set	71C	713C	67X16	713C, 71[illegible]	71[illegible], 71[illegible]Y
Receiving Decoder Group	71D	N/A	67X18	71G1	N/A
Assoc. Equipment	71R	71X3, 714	71X1	71X1	71X1
RADAR NAVIGATION	72	72	72, (-7291)	72, 73A3	72
Radar Altimeter Set	72A	7236, 7228	7228, 7236	7228, 7236	72[illegible], 72[illegible]
Doppler Radar Nav. Set	72B	7238	7238	73A3	N/A
Radar Beacon Set	72D	7239	7239	7239	N/A
Radar Set	72E	7219	7245, 724P	N/A	N/A
Assoc. Equipment	72P	72X1, 72Y1	72R, 72K	72Y1	N/A
BOMBING NAVIGATION	73	73	73, 7291	73, (-73A1/3/6)	73
Nav. Computer Set	73A	731, 739	N/A	N/A	N/A
Inertial Nav. System	73D	N/A	7345	73A5	7[illegible]
Display Set	73H	N/A	7291	73A4	73[illegible], 7[illegible]
Misc. Set/Group	73P	N/A	736A	735A, 73AP	N/A
Assoc. Equipment	73R	73R, 73K	73X2	73X1	N/A
WEAPONS CONTROL	74	74	74	74, 73A1	74
Radar Set	74A	N/A	N/A	73A1	N/A
Fire Control Set	74C	N/A	N/A	N/A	N/A
Fuse Function Control Set	74D	7485	74[illegible]	7496	N/A
AN/AWG-9 System	74E	N/A	N/A	N/A	N/A
Weapons Release Cont. Equip.	74F	7473, 7498	7498	7497	74[illegible]
Assoc. Equipment	74M	74X1	74X1	74Y1	N/A
Misc. Set/Equipment	74P	N/A	7493	N/A	74[illegible]
WEAPONS DELIVERY	75	75	75	75	75
Launchers/Racks/Rails	75A	754, 755, 759	754, 755	752, 753	754, 755, 75R
Gun	75B	753, 758	758	755	75[illegible]
Pylons	75C	N/A	N/A	756	75[illegible]
ECM	76	76	76	76	N/A
ECM System/Set/Equip.	76A	7631, 767	7673, 767L	7673, 767L	
Chaff Dispensing Set	76B	7665	7665	7665	
Radar Set	76D	7663	N/A	N/A	
Radar Receiver Set	76E	7666	763W, 7666	763W	
ECM Receiver Set	76K	N/A	763L	763L	
Assoc. Equip.	76Q	N/A	76R1	76R6, 76R3	
PHOTO/RECON	77	N/A	N/A	77	77
MISC. EQUIP./SYSTEMS	90	9K	9K	9K, (-911)	9K
Emergency Equip.	91	91	91	912	91
Drag Chute Equipment	93	93	N/A	N/A	N/A
Personnel Equipment	96	N/A	96	96	96
Explosive Devices	97	97	97	97	97

TABLE B-4 SWUC MATRIX

SYSTEM	STD WUC	F-4J	F-8J	F-14A	S-3A
AIRFRAME	11	11, 123, 148	11, 121, 493	11, 125, (-1125/6)	11
Structure	11A	1111, 1115, 1118, 1121, 1123, 113, (-11114) (-11115)	1111/2, 1115/7/8, 1121/3 1125/6, 1131/3, 1135/6, 1141/2, 1151/3, 1154/6	1112/4/7/8, 1121, 1131, 1135/6/7, 1141, 1151, 116, 118	1111/2, 1115/6/7, 112, 1131/3, 11510 → 11519 1161, 1191/2
Access Doors/Panels	11B	1112/3/4, 1116/7/9 111C, 1122, 1124	1114/6, 1122/4, 1132/4 1143, 1152/5	1115/6/9, 1122/3/4 1132/3/4, 1144, 1152	[illegible] 11[illegible]1A → 11510
Windshield	11C	11114	1113	111[illegible]	1114
Canopy	11D	11115, 1118, 123	121	1111, 125	
Wingfold	11E	148	493	N/A	119
FUSELAGE	12	12, (-123)	12, (-121)	12, (-125)	12
Ejection Seat Instl	12A	122	122	121	121
Cockpit Equip	12B	121	129	122, 123, 124	123
LANDING GEAR	13	13	13, (-1363)	13	13
MLG and Doors	13A	1321, 1323	131	131, 132	135, (-1363)
NLG and Doors	13B	1331, 1332	132	133, 134	132, (-1323)
Wheels/Tires	13C	1325, 1333	134	135	1321, 1353
Brake System	13D	134	135, 1372	138	1361, 1362, 1364, 1365
Steering System	13E	1334, 1335	133	139	133
LDG Controls	13F	131	136, 1371, (-1363)	136	1311, 1312, 1313
Arresting Gear	13G	135	138, (-1385)	13A	137
Catapulting System	13H	136	1385	13B	134
Emergency System	13J			137	1314, 1363
FLIGHT CONTROLS	14	14, (-148)	14, (-149), (-14641)	14	14
Control Stick Assy	14A	141	141, (-1415)	141	14110 → 1411A
Lateral Control System	14B	142	142	142	143
Longitudinal Control System	14C	143	144	144	1411B → 14119, [illegible]
Directional Control System	14D	144	143	143	145, 146
Flaps/Slats	14E	145	146, 147, (-14641)	146	147, 148
Speed Brake System	14F	146	148	147	
Wing Sweep System	14G	N/A	N/A	148	N/A
ENGINE	23	23	23	23	27
Basic Engine	23A	23A0, 23A1, 23A2, 23A3, 23A4	2360, 2361, 2362, 2363, 2364	2380, 2382, 2383, 2384	2710, 2711, [illegible], 2714
Accessory Drive System	23B	23A5	2365	2385	2715
Main Fuel System	23C	23A6, 23A7	2366, 2367	2386, 2387	2716
Lubrication System	23D	23A8	2368	2388	2718
Electrical System	23E	23A9	2369	2389	2719
Ignition System	23F	23AA	236A	238A	271A
Bleed Air System	23G	23AB	236B	238B	271B
AUXILIARY POWER UNIT	24	N/A	N/A	N/A	24, [illegible]
POWER PLANT INSTL	29	29	29	29	29, (-29A)
Engine Mount/Suspension	29A	291	291	291	291, 292
Power Plant Controls	29B	293	293	292/3, 297/8, 29K	293
Ignition Starting System	29C	295	295	295	294
Exhaust System	29D	296			
Approach Power Compensating	29E	29C	29C	29C	

TABLE B-5 SWUC MATRIX

SYSTEM	STD WUC	F-4J	F-8J	F-14A	S-3A
AIR CONDITIONING	41	41	41, 149	41, 493	41, 491/2/3/4
Air Conditioning	41A	411, 414, 416, 417	411, 412, 413	411	411
Pressurization	41B	412	414, 416	413, 41X1	41F
Ice/Rain/Wash Control	41C	413	415	415, 493	419, 491/2/3/4
Boundary Layer Control	41D	415	149	N/A	N/A
ELECTRICAL	42	42	42	42	42
Generator Drive System	42A	422	421	4211	42111, 42112, 42113
AC Power Supply	42B	4212, 4214	422, (-42216/21/27/2H)	4212, 422, 4215	42114 → 42119
DC Power Supply	42C	4213, 4216	42216/21/27/2H	4213	422
Power Distribution System	42D	4211, 4215	423	423, 425	424
Aircraft Wiring	42E	428	428	426	429
LIGHTING	44	44	44	44	44
Exterior Lighting	44A	442	441	441	441
Interior Lighting	44B	441	442	442, 44X	442
HYDRAULIC	45	45, (-453)	45, (-4511F)	45	45
Normal	45A	4511, 4512	451	4511, 4513, 4514	451, 452, 453
Emergency/Auxiliary	45B	4513, 4514, 455	452	4515, 4516	454
Pneumatic	45C	452	453		
FUEL	46	46, (-464)	46	46	46
Internal Fuel System	46A	461	462/3/4/5/9	461	462/2/3/4/9
External Fuel System	46B	462, 465, 46A, 46C	46A	462	466
Aerial Refueling System	46C	463	462	463	469
OXYGEN	47	47	47, (-472)	47	47
MISC. UTILITIES	49	49, 453	49, (-493)	49, 59, (-492/3/X1)	49, (-491/2/3/4/6)
Fire Detection	49A	491	491	49D	495, 498
Flight Recorder System	49B	N/A	492	N/A	N/A
On-Aircraft Test Equipment	49C	N/A	N/A	495, 59	N/A
Air Driven Turbine Systems	49D	453		N/A	N/A
INSTRUMENTS	51	51, 464	51, 14641, 4511F, 472 (-5119), 1363	51, 492, 49X1	51, 496, (-5112)
Flight/Nav Instruments	51A	511, 512	511, 512, (-5119)	511, 512	5111
Engine Instruments	51B	514	515	513	513
Fuel Quantity Indication	51C	5184, 464	514	5152	515
Position Indication (13,14)	51D	516, 517	513, 14641, 1363	514, 5154	514
Utility Indication (45,47)	51E	5181, 5182, 5185	4511F, 472	5151, 5153	516, 517, 519
Advisory/Warning Indication	51F	N/A	N/A	492, 49X1	496
FLIGHT REFERENCE	56	56	56, 5119	56	56, 5112
Angle of Attack Indication	56A	5686	5119	563, 56X1C, 56X1D	5112
Air Data Computer	56B	564		56X18, 56X25	567
Attitude Heading & Reference	56C	562, 56X1	56X1	56X17	562
INTEGRATED FLIGHT CONTROL	57	57	57	57	57
COMMUNICATIONS	60	6X, (-6718M), (-6717)	6X	6X	6X
VHF Communication	62	N/A	N/A	N/A	N/A

TABLE B-6 SWUC MATRIX

SYSTEM	STD WUC	F-4J	F-8J	F-14A	S-3A
UHF Comm.	63	63,6712Q,67X1F/G/J, (-6351)	63	63	63, (-6351)
Interphone	64	64	N/A	64	64
IFF	65	65, 67X11	65	65	65
Emergency Radio	66	66	66	66	66
CNI	67	67, (-6712M/Q), (-6717), (-67X11), (-67X1F/G/J)	67	67	67
Misc. Comm.	69	6351	N/A	69	69, 6351
RADIO NAVIGATION	71	71, 6712V, 6717	71	71	71
Direction Finder Group/Set	71A	7116	7113	7116	7116, 7148
TACAN Set	71C	6712M, 6717	7143	713, 714	713C
Receiving Decoder Group	71D	71B1	71D1	71D1	71D1
Assoc. Equipment	71Q	71X1, 717	71X1	71X1	71R5, 71Y2
RADAR NAVIGATION	72	72	72	72	72
Radar Altimeter Set	72A	7236, 722B	7224	722B	722X
Doppler Radar Nav. Set	72B	N/A	N/A	N/A	722F
Radar Beacon Set	72D	7239	N/A	7239	729D
Radar Set	72E	N/A	N/A	N/A	727N, 729F
Assoc. Equipment	72P	72X1	72X1	72Y1	72Q1, 72Y1
BOMBING NAVIGATION	73	73	73	73	73
Nav. Computer Set	73A	7312, 7349	N/A	N/A	N/A
Inertial Nav. System	73D	N/A	N/A	734N	734N, 7386
Display Set	73H	N/A	N/A	N/A	N/A
Misc. Set/Group	73P	N/A	732N	N/A	73, (-734N/86/X2)
Assoc. Equipment	73R	N/A	N/A	73R7	73X2
WEAPONS CONTROL	74	74	74	74	74
Radar Set	74A	7426, 7427, 742B	7433, 7436, 7445	N/A	N/A
Fire Control Set	74C	7482	7478	743D	N/A
Fuse Function Control Set	74D	N/A	N/A	74RE	N/A
AN/AWG-? System	74E	N/A	N/A	74A	N/A
Weapons Release Cont. Equip.	74F	749	N/A	N/A	N/A
Assoc. Equipment	74M	74Y2	N/A	74R1, 74X1, 74Y1	N/A
Misc. Set/Equipment	74P	74Q1	N/A	N/A	74
WEAPONS DELIVERY	75	75	75	75, 1125/6	75
Launchers/Racks/Rails	75A	751, 752, 753	752, 759	751, 752, 753	751, 75R
Gun	75B	758	754	756	N/A
Pylons	75C	757	755	1125/6	N/A
ECM	76	76	76	76	76
ECM System/Set/Equip.	76A	7673, 767L	7673	7673	N/A
Chaff Dispensing Set	76B	7665	7665	7665, 766M	N/A
Radar Set	76D	N/A	7663, 7664, 766B	7663	N/A
Radar Receiver Set	76E	763W, 7666	N/A	763W, 7666	N/A
ECM Receiver Set	76K	763L, 763	N/A	763L	7686
Assoc. Equip.	76Q	76R5, 76X3	76X2	76M4, 76X	N/A
PHOTO/RECON	77	77	77	N/A	77
MISC. EQUIP./SYSTEMS	90	9X	9X	9X	9X
Emergency Equip.	91	91	91	91	91
Drag Chute Equipment	93	93	N/A	N/A	N/A
Personnel Equipment	96	96	96	96	96
Explosive Devices	97	97	97	97	97

APPENDIX C

A-7A/F-14A MAINTAINABILITY DEMONSTRATION RESULTS

Analysis of the A-7A and F-14A maintainability demonstrations indicates a mathematical relationship exists between the maintenance time reported by technicians and the maintenance time measured by monitors. A discussion on the findings of the analysis follows.

The A-7A was the first aircraft to undergo a formal maintainability demonstration (Reference 20). The demonstration was conducted at U.S. Naval Air Station, Cecil Field, Florida over a three month period in 1967 using six aircraft. A major finding of the demonstration was that Class 2 3-M reported unscheduled MMH/FH exceeded Class 3 design controllable MMH/FH by approximately two to one (Table C-1).

TABLE C-1 A-7A MAINTAINABILITY DEMONSTRATION RESULTS

MAINT. LEVEL	UNSCHEDULED MMH/FH		
	3M REPORTED	DESIGN MEASURED	3M:DESIGN
0	3.53	1.70	2.08:1
I	1.92	1.04	1.84:1
O&I	5.45	2.74	1.99:1

In an attempt to expand on this finding, a study effort was conducted by Vought. Individual maintenance action forms were re-examined to relate 3-M reported manhours and elapsed maintenance time with design measured time. Cost and schedule constraints prevented this at the time of the demonstration.

During the three month demonstration period, 788 Organizational ("O") level and 318 Intermediate ("I") level unscheduled maintenance actions were reported. A statistical sampling size of 50 O-level and 30 I-level maintenance actions were selected based on "judgement sampling" techniques (Reference 5). Attachment 1, Tables 1 and 2 contain a listing of the sample data. Care was taken to insure the sample size was representative of the actual data base. That is, (1) all forms were filled out completely and correctly, (2) for every Maintenance Action Form (MAF) there was a comparable Maintainability Analysis Data Form (MADF), (3) only Class 2 contractor responsible maintenance actions were considered and (4) an equal distribution of maintenance actions existed between the sample data and the actual data base. The next step was to extract manhours and elapsed maintenance time from each form and apply regression analysis techniques to the data.

Figure C-1 shows the results of one such analysis, a plot of MMH/MA at O-level. Results indicated a relationship between MAF time and MADF time. Correlation was good and the sample mean agreed closely with the actual mean. Also, it appeared the technicians rounded-off their time to the nearest hour or half hour. Similar relationships were developed for MMH/MA at I-level and for EMT/MA at O and I levels with good correlation results.

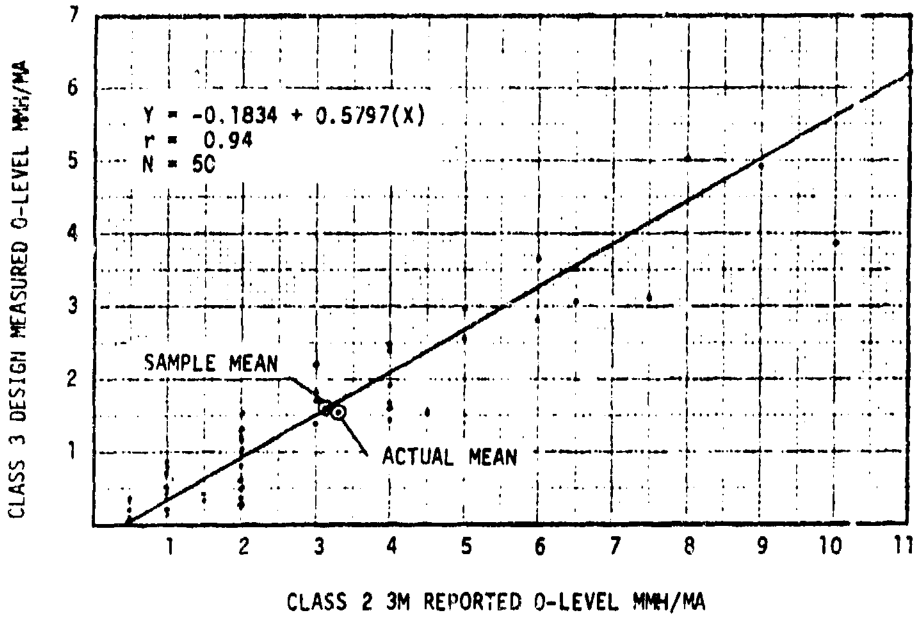

FIGURE C-1 A-7A 3M AND DESIGN MMH/MA RELATIONSHIP

A breakdown of maintenance time into mechanical and avionic systems was investigated, but results showed little separation in the data. This indicated Navy controllable maintenance time was roughly the same whether the maintenance action was mechanical or avionic related.

Since the A-7A demonstration, the ground rules for maintainability demonstrations and evaluations have been expanded. The ground rules now include preparation and cleanup time as contractor controllable time. The next aircraft to undergo a full maintainability demonstration was the F-14A.

The F-14A Fleet Supportability Evaluation (FSE) was conducted at U.S. Naval Air Station, Miramar, California (Reference 1). From 1 to 24 aircraft participated in the evaluation which was conducted over a six month period (November, 1973 through April, 1974). During this time period, 5881 O-level and 1303 I-level maintenance actions were reported. Like the A-7A demonstration, two types of forms were used to record maintenance data: (1) an Evaluation Record (ER) sheet prepared by maintainability monitors and (2) a MAF prepared by technicians. Personnel limitations allowed the monitoring of only 63% of the maintenance actions. The remainder had to be reconstructed at the end of each day using MAF data and past experience of similar actions. A summary of FSE data collected is shown in Attachment 2, Table 1. Measured data was derived from the F-14A FSE report (Reference 1). Reported data was extracted from 3-M FMSO data tapes for that time period and processed using Vought computer programs. A more detail examination of F-14A 3-M/FSE data was not possible since the individual MAF's and ER's were not available

Based on available A-7A and F-14A demonstration data, it was possible to establish 3-M to FSE maintenance time conversions. Analysis of A-7A data showed 52% of the 3-M reported O-level MMH/MA was design controllable. Similarily, analysis of F-14A data showed 62% of the 3-M time was design controllable, Table C-2. Assuming the method of measuring time was essentially the same, the difference can be attributed to preparation and cleanup time which was not counted in the A-7A demonstration.

TABLE C-2 REPORTED - VS - MEASURED MMH/MA

ACFT	MAINT. LEVEL	UNSCHEDULED MMH/MA 3M REPORTED	FSE MEASURED	FSE:3M
A-7A	0 I	3.15 2.93	1.64 1.87	52% 64%
F-14A	0 I	5.28 7.59	3.26 5.92	62% 78%

A modification to Figure C-1 was made to include preparation and cleanup time. Figure C-2 shows this relationship as a line drawn parallel to the A-7A regression line and through the F-14A mean value.

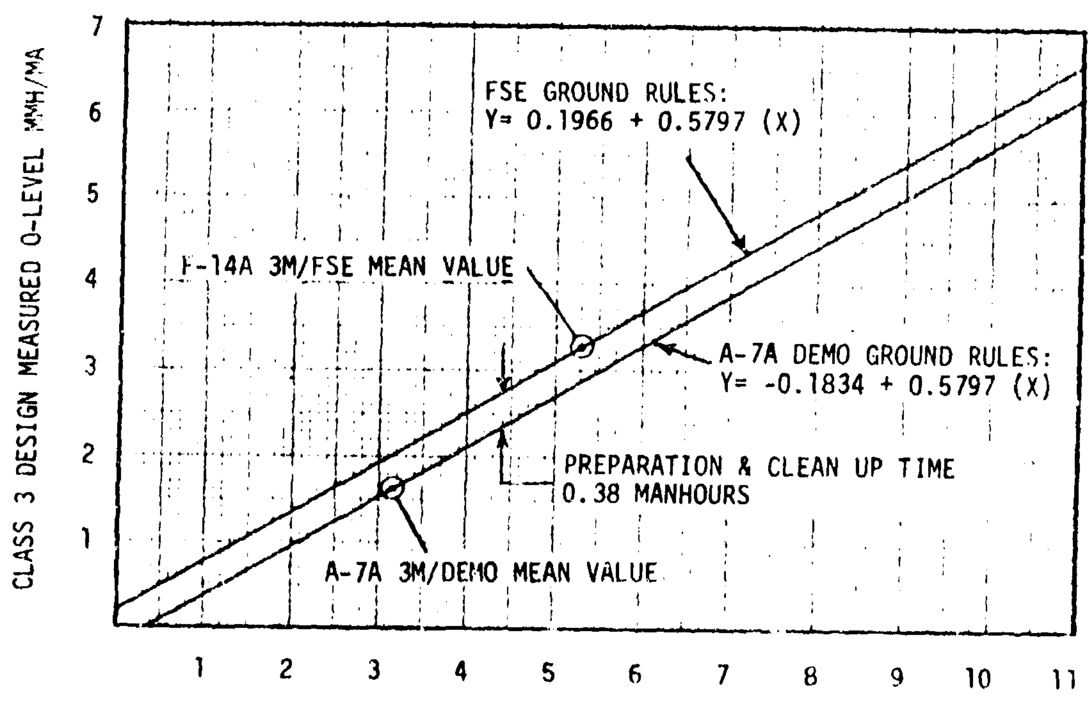

FIGURE C-2 RELATIONSHIP BETWEEN 3M AND DESIGN MAINTENANCE TIME

[illegible] the conv[illegible] [illegible] were made for MMH/MA at I-level and [illegible]/MA at [illegible] [illegible] levels. These relationships are expressed by a set of equations shown in Figure C-3.

PA[illegible]TER	M[illegible]	EQUATION
[illegible] MA	[illegible]	$Y_1 = 0.1966 + 0.5797 (X_1)$
[illegible] MA	O	$Y_2 = 0.2126 + 0.5170 (X_2)$
[illegible] MA	[illegible]	$Y_3 = 0.3026 + 0.6215 (X_3)$
[illegible] MA	I	$Y_4 = 0.1606 + 0.6497 (X_4)$

[illegible] MAIN[illegible] TIME
[illegible] MAINT[illegible] TIME
[illegible] CONTROLLABLE MAINT TIME

F[illegible] [illegible] Reported Versus Measured Time Relation[illegible]

The validity [illegible] aircraft demonstrations as being representative [illegible] [illegible] experience can al[illegible] [illegible] questioned. It is true that [illegible] [illegible] demonstrat[illegible] [illegible] highly tra[illegible] [illegible] to perform maintenance [illegible] [illegible] [illegible] monitors [illegible] [illegible] in time measurements. However, [illegible] this [illegible] [illegible] the relation[illegible] between the technician's reported time [illegible] the [illegible] measured time is [illegible]ndent of job efficiency. It doesn't matter how [illegible] [illegible] is complete[illegible] What is important is the amount [illegible] [illegible] [illegible] [illegible] time [illegible]iated with each maintenance [illegible] [illegible] [illegible] compensated for in the above equations. Thus if a job takes longer to complete in the field, both contractor and Navy controllable maintenance time increase accordingly.

The conclusion from this analysis is two fold:

[illegible] Fleet reported [illegible] can be rapidly converted to [illegible] controllable [illegible] using the equations shown in Figure C-3.

[illegible] Conversely, th[illegible] equations can be used during design development for converting inherent maintainability to operational maintainability.

TABLE 1. A-7A MAINTAINABILITY DEMONSTRATION DATA - O LEVEL

SAMPLE NO.	WUC	MAINT LEVEL	ACTION TAKEN CODE	MALF CODE	REPORTED		MEASURED	
					MMH	EMT	MMH	EMT
1	11120	0	R	846	3.0	1.5	2.23	1.07
2	1131C	0	C	190	4.0	2.0	1.67	1.00
3	1311B	0	C	780	2.0	2.0	1.32	0.92
4	13130	0	R	020	1.0	1.0	0.23	0.23
5	13130	0	R	020	2.0	1.0	0.37	0.18
6	13130	0	R	020	0.5	0.5	0.38	0.38
7	13151	0	R	020	1.0	0.5	0.17	0.08
8	14234	0	C	381	6.0	3.0	3.66	2.33
9	1423C	0	C	381	2.0	1.0	1.05	0.77
10	14244	0	R	242	1.5	1.0	0.33	0.17
11	14631	0	C	127	0.5	0.5	0.10	0.10
12	14730	0	C	947	4.0	2.0	2.40	1.20
13	14763	0	C	381	10.0	5.0	3.88	2.42
14	14782	0	C	127	4.0	2.0	1.62	1.33
15	23171	0	B	190	2.0	2.0	1.37	1.37
16	23200	0	C	334	4.5	1.5	1.55	0.43
17	23200	0	C	334	3.0	1.0	1.40	0.47
18	23400	0	C	525	3.0	1.0	1.72	0.58
19	42311	0	R	450	2.0	1.0	1.25	0.65
20	45200	0	C	070	12.0	6.0	9.25	3.22
21	45200	0	R	381	1.0	1.0	0.37	0.37
22	45200	0	C	381	0.5	0.5	0.20	0.20
23	45216	0	R	900	0.5	0.5	0.33	0.22
24	45231	0	R	242	6.5	4.0	3.07	1.30
25	45231	0	R	561	6.0	4.0	2.83	1.83
26	51152	0	R	135	1.0	1.0	0.42	0.42
27	57222	0	B	381	9.0	3.0	4.92	1.68
28	71211	0	R	242	2.0	1.0	1.20	0.85
29	72115	0	R	242	1.0	1.0	0.87	0.52
30	73110	0	C	127	2.0	1.0	1.38	1.00
31	7311C	0	C	958	2.0	1.0	0.50	0.40
32	73110	0	C	160	4.0	2.0	1.92	1.17
33	73110	0	C	472	7.5	2.5	3.12	1.15
34	7311C	0	C	127	4.0	2.0	1.45	0.83
35	73110	0	C	127	1.0	0.5	0.72	0.38
36	73111	0	R	242	5.0	2.5	2.57	2.00
37	73111	0	C	029	5.0	2.0	2.96	1.50
38	73111	0	C	127	2.0	1.0	0.97	0.62
39	73111	0	R	242	2.0	1.0	0.72	0.30
40	73111	0	R	242	4.0	2.0	2.43	1.10
41	73118	0	R	127	8.0	4.0	5.08	1.97
42	73118	0	R	242	3.0	1.0	1.78	0.78
43	73221	0	R	242	2.0	1.5	0.60	0.37
44	73221	0	R	242	1.0	1.0	0.83	0.58
45	73221	0	R	242	1.5	1.0	0.40	0.20
46	73221	0	R	242	2.0	1.0	1.02	0.58
47	73221	0	R	242	1.0	1.0	0.48	0.48
48	73222	0	R	242	1.0	1.0	0.79	0.35
49	73222	0	R	242	2.0	2.0	1.53	1.53
50	73222	0	R	242	2.0	1.0	0.80	0.72
				MEAN VALUE	3.15	1.67	1.64	0.89

TABLE 2. A-7A MAINTAINABILITY DEMONSTRATION DATA - I LEVEL

SAMPLE NO.	WUC	MAINT LEVEL	ACTION TAKEN CODE	MALF CODE	REPORTED		MEASURED	
					MMH	EMT	MMH	EMT
1	[illegible]	I	C	782	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	C	782	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	I	C	782	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	I	C	782	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	381	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	160	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	381	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
11	[illegible]	I	[illegible]	374	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	C	127	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	C	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	C	127	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	C	160	[illegible]	[illegible]	[illegible]	[illegible]
17	[illegible]	[illegible]	C	901	[illegible]	[illegible]	[illegible]	[illegible]
18	[illegible]	[illegible]	C	383	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	I	C	127	[illegible]	[illegible]	[illegible]	[illegible]
20	[illegible]	[illegible]	C	255	[illegible]	[illegible]	2.02	[illegible]
21	73111	I	C	615	2.6	1.3	1.40	0.63
[illegible]	[illegible]	I	C	901	2.0	2.0	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	C	900	[illegible]	[illegible]	[illegible]	[illegible]
24	73211	[illegible]	C	306	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	73221	I	C	169	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	73221	[illegible]	C	160	[illegible]	[illegible]	0.98	[illegible]
27	73221	I	C	127	[illegible]	[illegible]	[illegible]	[illegible]
28	73221	I	C	127	[illegible]	[illegible]	[illegible]	0.75
29	73221	I	C	127	[illegible]	[illegible]	[illegible]	0.62
30	73222	I	C	127	[illegible]	[illegible]	[illegible]	0.72
MEAN VALUE					2.93	2.39	1.87	[illegible]

TABLE 1. F-14A FLEET SUPPORTABILITY EVALUATION DATA

WUC	SYSTEM	O LEVEL				I LEVEL			
		REPORTED		MEASURED		REPORTED		MEASURED	
		MMH/MA	EMT/MA	MMH/MA	EMT/MA	MMH/MA	EMT/MA	MMH/MA	EMT/MA
11	AIRFRAME	4.24	2.14	3.61	NOT AVAILABLE	9.24	4.62	2.94	NOT AVAILABLE
12	FUSELAGE COMP	2.50	1.38	1.72		6.88	4.25	10.30	
13	LANDING GEAR	4.38	1.83	3.15		3.89	2.41	2.84	
14	FLIGHT CONTROLS	13.26	4.84	9.18		5.89	3.22	3.64	
27	ENGINE	10.24	3.69	7.24		12.64	4.18	22.89	
29	POWER PLANT INSTL.	7.62	2.92	5.23		5.73	3.83	3.61	
41	AIR CONDITIONING	7.76	3.55	5.82		13.27	6.00	4.58	
42	ELECTRICAL	6.27	3.07	5.06		7.79	5.29	10.30	
44	LIGHTING	1.65	1.06	1.14		9.44	6.05	6.18	
45	HYDRAULICS	7.22	2.80	4.22		3.63	2.68	4.12	
46	FUEL	7.55	3.38	5.67		0.82	0.82	0.82	
47	OXYGEN	1.83	1.26	1.08		1.75	1.75	7.49	
49	MISC. UTILITIES	5.28	2.05	3.47		14.86	8.71	14.98	
51	INSTRUMENTS	7.35	3.18	4.51		4.74	2.65	3.30	
56	FLIGHT REFERENCE	4.60	1.89	3.02		4.61	4.43	4.34	
57	INTEG. GUID/FLT CONT	7.50	2.88	2.21		18.04	12.91	14.98	
63	UHF	3.00	1.34	1.35		2.87	2.33	2.17	
64	INTERPHONE	4.53	1.90	2.63		1.40	1.20	0.92	
65	IFF	4.26	1.93	2.29		2.09	1.77	1.29	
67	CNI	1.59	0.87	0.98		2.00	2.00	2.17	
69	MISC COMM	3.40	1.42	1.79		5.61	5.08	4.39	
71	RADIO NAV	2.75	1.14	1.88		2.73	2.16	2.47	
72	RADAR NAV	4.40	2.28	1.87		3.63	3.25	0.92	
73	BOMB NAV	3.67	1.46	2.40		39.97	15.74	17.85	
74	WEAPONS CONTROL	4.05	1.61	2.11		8.84	7.10	7.41	
75	WEAPONS DELIVERY	9.90	2.55	4.00		3.54	2.14	4.12	
76	ECM	9.53	3.84	3.23		19.44	13.28	5.98	
91	EMERGENCY EQUIP	1.00	0.68	0.71		2.00	2.00	-	
96	PERSONNEL EQUIP	-	-	-		-	-	-	
97	EXPLOSIVE DEVICES	4.75	2.13	1.17		-	-	-	
	TOTAL UNSCHEDULED	5.28	2.18	3.26	-	7.59	5.34	5.92	-

APPENDIX D

ADJUSTMENT OF SCHEDULED MAINTENANCE REQUIREMENTS THROUGH ANALYSIS

(ASMRA)

The Adjustment of Scheduled Maintenance Requirements through Analysis (ASMRA) is a series of computer programs used to process and display maintenance data collected by means of the Navy's Maintenance, Management, and Material System (3-M). The ASMRA programs are a product of The Naval Aviation Integrated Logistics Support Center (NAILSC), Logistics Engineering Department, Patuxent River Naval Air Station, Maryland. The programs, first used in 1972, were developed to support changes in the Navy's scheduled maintenance concept. As usage of the programs increased, additional uses were envisioned and the scope of the computer programs was vastly enlarged. Although the acronym ASMRA still retains Scheduled Maintenance in its title, the computer programs now in use are versatile and diverse, allowing the application of 3-M maintenance data to a wide spectrum of engineering and logistics studies and problems.

The NAILSC ASMRA system programs differ from those offered by the Fleet Maintenance Support Office (FMSO) although both organizations utilize the same raw 3-M data. The ASMRA system consists of a network of users tied via telephone data lines and remote terminals to a central computer located in San Antonio, Texas. Users in the ASMRA network input their programs and receive the output, usually within a couple of hours, at their remote terminal facility. FMSO is located in Mechanicsburg, Pennsylvania, and reports are all generated and distributed from that facility.

The core or basic program in ASMRA is a series of routines called Equipment Condition Analysis (ECA). A great many of the ASMRA programs are run from a specially coded magnetic tape of 3-M data generated in ECA. On this tape (file) is historical maintenance data which is updated monthly using incoming 3-M receipts. Two dates appear on the Visual Information Display System/Maintenance Action Form which are important toward understanding how the ASMRA data is processed and why it differs slightly from the manner in which FMSO processes the same data. These dates are the JCN (Job Control Number) Date and the Action Date, and they differ in the following manner.

The date the maintenance action occurred is recorded as the JCN Date while the date on which all maintenance is completed, at any given level of maintenance, is called the Action Date. The NAILSC updates the ECA files using a data base of three consecutive months ending on the most recent Action Date received. The ECA file and the data entered via updates is then structured by JCN. Reference Figure D-1. (The JCN includes the JCN Date as an integral part of the number and each JCN is unique to a set of documents.) All maintenance pertaining to a particular action, regardless of maintenance level, including spin-off sub-component repair, will have the same JCN. Structuring the file using the JCN allows all maintenance on that action to be grouped together creating an auditable trail. Some monthly FMSO reports are also processed by JCN, but the basic historical files are structured, over time, by Action Date. Therefore, the primary difference between the ASMRA system and the FMSO data is the continual update of ASMRA files using a JCN structure rather than the FMSO preferred Action Date. The resultant ASMRA reports then, present a more complete

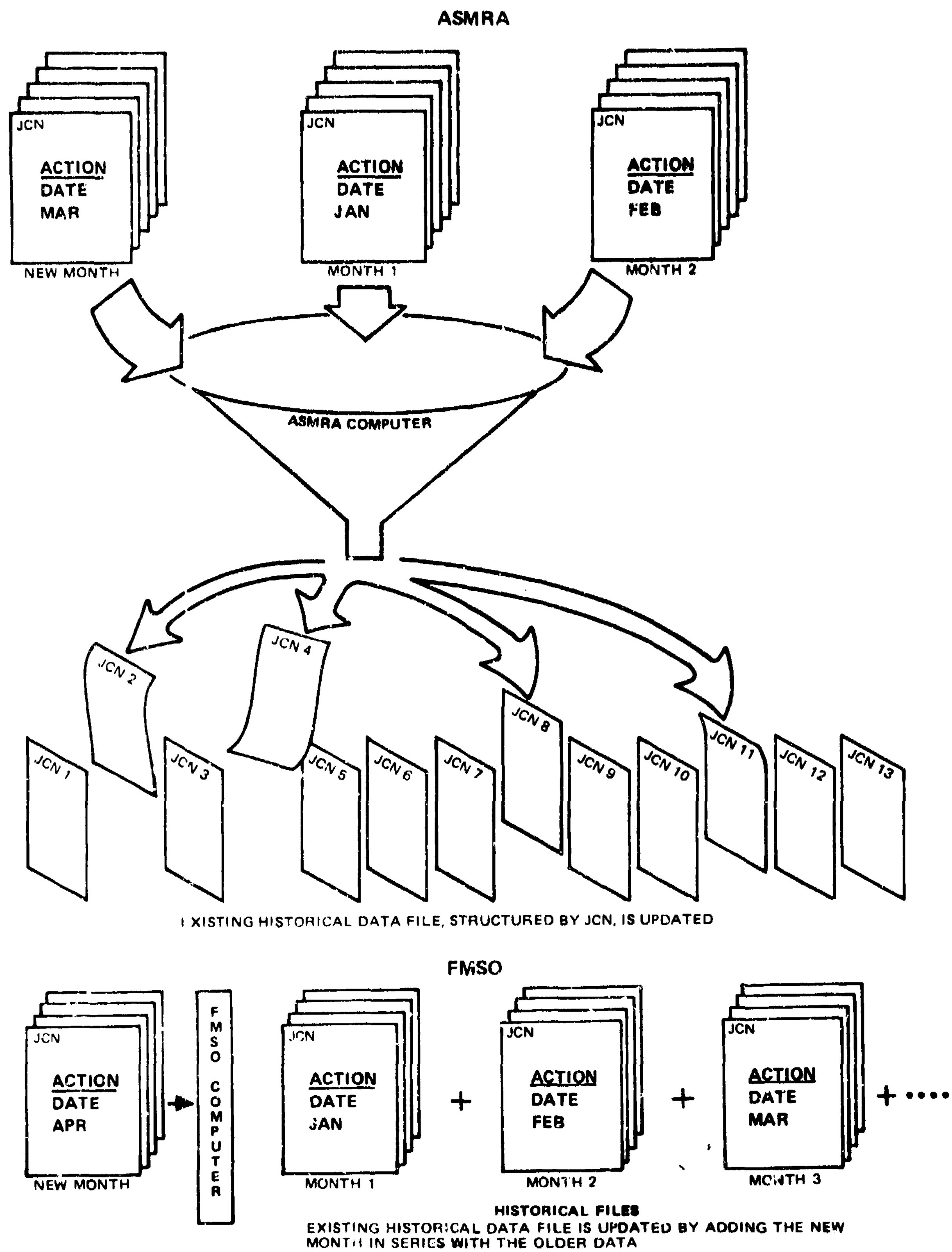

Figure D-1 Historical File Generation, ASMRA vs FMSO

picture of maintenance history, and therefore, maintenance performed in a given time frame, than similar FMSO standard reports.

Once the ECA data file is created, several series of ASMRA programs utilize it. One of these computer programs is the Equipment Cross Index Program (ECIP) which was "...developed to provide comparative maintenance data for determining specific Maintainability (M) inputs to new procurement programs, and for comparative analysis of in-service equipments' performance."[1] The ECIP differs from other data programs in that it uses a Cross-Index Code (CIC) rather than the Work Unit Code (WUC) to categorize equipments. Equipment is treated according to function in ECIP. For example, all cockpit canopies would be under the same CIC. (The CIC's were needed because the current WUC system is not consistent in its assignment of codes for functional components.) When all functional components are grouped together, comparison from aircraft to aircraft may be made with some assurance that the analyst is comparing like data.

The ECIP programs provide output in tabular and graphical form. This handbook utilized only the tabular. Data was run for the time period July, 1975, through December, 1976 except for the F-8J. F-8J data was obtained on the time frame July, 1974 through December, 1975 because the aircraft was being phased out during the later time period and a more complete, older base was needed. The tabular data was supplied to Vought Corporation on magnetic tape to facilitate in-house manipulation.

Navy 3-M data contained in the tabular ECIP report for each CIC and corresponding Navy WUC is as follows: Organizational level Maintenance Manhours, Maintenance Actions, Elapsed Maintenance Time and Failures; Intermediate level Maintenance Manhours, Maintenance Actions, Elapsed Maintenance Time, and Failures; and, Organizational and Intermediate level combined Maintenance Manhours, Maintenance Actions, Elapsed Maintenance Time, and Failures. Work Unit Codes to be discussed in detail in Section 6.0 of this Handbook were then extracted from the magnetic tapes.

Manhours and elapsed maintenance time, presented in Section 6.0 of this Handbook, as extracted from ASMRA, are the total times reported on 3-M card types (CT) 11, 21, and 31 at each level of maintenance. The definition of maintenance action is drawn from ECIP and, at Organizational level, is defined as one maintenance action for each unique Organizational JCN. At Intermediate level it is defined similarly except it includes not only each unique Intermediate level JCN, but also a count of Organizational level JCN's worked on at Intermediate level. It is essentially a count of 3-M CT31's.[2] "Failures

1. ASMRA User's Guide, Volume I, NAILSC, Patuxent River, Maryland, p. [illegible]
2. ASMRA User's Guide, Volume III, NAILSC, Patuxent River, Maryland, p. [illegible]

[reported in ECIP] are defined as the number of maintenance actions confirmed as failures by the action taken codes [sic] 1 through 9, B, C, or Z and a MAL (Malfunction) code other than the following conditional malfunctions:

000	246	730	801
086	301	731	803
093	303	758	804
105	311	787	805
108	447	788	806
142	602	799	878
158	651	800	931"3.

Tables D-1 and D-2 from Reference 4 define the meanings of the Action Taken and Malfunction Codes.

The ECIP data provided all the information needed except the values for average Organizational remove and replace time. This information was extracted from the ASMRA ECA series of computer programs. Maintenance Actions (MA) and Elapsed Maintenance Time (EMT) were obtained for only those maintenance actions which were coded with Action Taken Code "R", Remove and Replace, regardless of Malfunction Code. The resultant quotient of EMI ÷ MA represents the average time experienced to remove and replace a given piece of equipment. Remove and replace time used in Section 6.0 represents the time frame January, 1975 through July, 1976.

3. User's Guide, pp. 13-16.

TABLE D-1 MALFUNCTION (MAL) CODES

MALFUNCTION CODE	
001	Gassy
003	Open Filament or Tube Circuit
004	Low GM or Emission
007	Arcing, Arced
008	Noisy
009	Microphonic
010	Poor Focus
020	Worn, Stripped, Chafed, Frayed
028	Conductance Incorrect
029	Current Incorrect
*030	Ground Accident/Incident Damage
037	Fluctuates, Freq/RPM Unstable, Intermittent
050	Blistered
051	Fails to Tune/Drifts
064	Incorrect Modulation
065	High Voltage Standing Wave Ratio
069	Flame Out
070	Broken, Burst, Ruptured, Punctured, Torn, Cut
080	Burned Out Light Bulbs or Fuses
*086	Improper Handling
*087	Improper Identification
088	Incorrect Gain
*092	Mismatched-Electronic Parts, etc
*093	Missing Part
*105	Loose, Damaged, or Stripped Bolts, Nuts, Screws, Rivets, Fasteners, Clamps or Other Common Hardware
106	Missing Bolts, Nuts, Screws
*108	Broken, Faulty or Missing Safety Wire or Key

MALFUNCTION CODE	
117	Deteriorated/Eroded
127	Adjustment or Alignment Improper
130	Change of Value
135	Binding, Stuck or Jammed
*142	Engine Removed-Excessive Maintenance
150	Chattering
*168	Launch Damage
160	Broken Wires, Defective Contact or Connection
161	Output Incorrect
163	Slip Ring/Commutator Failure
167	Torque Incorrect
169	Incorrect Voltage
170	Corroded
177	Fuel Flow Incorrect
180	Clogged, Obstructed, Plugged
181	Compression Low
183	Magnetic Tape Broken
185	Contamination
188	Glazed
190	Cracked, Crazed
242	Failed to Operate Specific Reason Unknown
*246	Improper or Faulty Maintenance
255	No Output
257	Off Color
277	Fuel Nozzle Coking
279	Spray Pattern Defective
281	High Output, Reading or Value
282	Low Output, Reading or Value
290	Fails Diagnostic/Automatic Tests

MALFUNCTION CODE	
291	Fails Auto Check
292	Fails Acceptance Test
293	Fails Self Check
294	Fails Self-Test
*301	Foreign Object Damage
*303	Bird Strike Damage
*304	FOD - Self-Inducted by Ingestion of Aircraft Parts, i.e., Dzus Buttons, Rivets, Pieces of Fairing, etc.
306	Non-metallic Contamination or Dirty
*311	Hard Landing
314	Acceleration Improper
317	Hot Start
318	Deceleration Improper
320	Starting Stall/Hung Start
330	Excessive Hum
334	Temperature Incorrect
350	Insulation Breakdown
372	Metal in Oil Strainer, Filter, etc.
374	Internal Failure
381	Leaking - Internal or External
383	Lock-On Malfunction
398	Oil Consumption Excessive
410	Lack of, or Improper Lubrication
416	Out of Round
424	External Power Source
425	Nicked or Chipped
429	Peeled
437	Improperly Positioned/Selected, or Other Operator Error

MALFUNCTION CODE	
*447	Wrong Logic Program or Computer
450	Open
457	Oscillating
458	Out of Balance
464	Overspeed
481	Keyway or Spline Damaged or Worn
503	Sudden Stop
520	Pitted
525	Pressure Incorrect
537	Low Power or Thrust
561	Unable to Adjust to Limits
567	Resistance High
568	Resistance Low
583	Scope Presentation Incorrect-Faulty
585	Sheared
599	Travel or Extension Incorrect
601	Detonation
*602	Failed, Damaged or Replaced Due to Malfunction of Associated Equipment or Item
603	Oil in Induction System
604	Manifold Pressure Beyond Limits
606	Counter Run-Off, Position Indicator
607	No-Go Indication; Specific Reason Unknown
615	Shorted
617	Sulfidation
622	Wet
*649	Sweep Malfunction
*651	Air in System
652	Automatic Align Time Excess
653	Ground Speed Error Excessive
664	Tension Low

Source: OPNAVINST 4790.2A, Volume II, Change 6, 20 September 1976, Appendix E, Table B, pp. E11 E18.

TABLE D–1 (Continued) MALFUNCTION (MAL) CODES

MALFUNCTION CODE	
679	Signal Distortion
681	[illegible] Defective Shutter
682	No [illegible] or Drift
683	No [illegible] Improper [illegible]
684	Weak No [illegible]
685	No Shutter Trip Pulse
686	Runaway Operation
687	Hard or Late Afterburner Light
688	Manual Transfer Improper
689	Shutdown Improper
690	Vibration Excessive
692	Video Faulty
693	Audio Faulty
694	Audio and Video Faulty
695	Sync Absent or Faulty
696	Fluid Low
697	Program, Faulty Tape
698	Program, Faulty Card
703	Program Failure
704	Memory Protect
705	Program Deterioration
706	Magnetic Tape, Error
707	Shorted, Internal
710	Bearing, Failing or Faulty
719	Broken/Frayed Bonding/Ground Wire
720	Brush Failure/Worn Excessively
*730	Loose
*731	Battle Damage
*758	Obsolete or Surplus
766	Out of Specification

MALFUNCTION CODE	
780	Bent, Buckled, Collapsed, Dented, Distorted, or Twisted
781	Tire Leakage Excessive
782	Tire Tread Area Defective Use Cut, Delaminated, Punctured, Worn, etc., if applicable
783	Tire Sidewall Damaged or Defective
784	Tire Bead Area Damaged or Defective
785	Tire Inside Surface Damaged or Defective
786	Tire Blowout
*787	Tire Removal, Normal Wear
788	Tire Removal Due to Other Primary Cause
*799	No Defect
*800	No Defect - Component Removed and/or Re-installed to Facilitate Other Maintenance
*801	No Defect - Removed for Modification
*803	No Defect - Removed for Time Change
*804	No Defect - Removed for Scheduled Maintenance
*805	No Defect - Removed for Pool Stock
*806	No Defect - Removed as Part of a Matched System
*807	No Defect - Removal Directed by Higher Authority
*811	No Defect - Removed During Troubleshooting
816	Impedance High
817	Impedance Low
823	No Start
838	B-Plus High
839	B-Plus Low
846	Delaminated
*877	Transportation Damage
*878	Weather Damage
900	Burned or Overheated

MALFUNCTION CODE	
913	Non-Repeatable MIL/Intermediate Trim
914	Non-Repeatable Idle Trim
916	Impending or Incipient Failure Indicated by Spectrometric Oil Analysis
921	Engine Monitoring System Indicates Further Investigation Required
922	Engine Monitoring System Indicates Overtemp Limits Exceeded
923	Engine Monitoring System Indicates Early Inspection Required
*931	Accidental or Inadvertent Operation, Release, or Activation
932	Does Not Engage, Lock or Unlock Properly
935	Scored, Scatched, Burred, Gouged
938	Power Output Dip
955	Data Link High Error
956	Abnormal Function of Computer Mechanical Equipment
957	No Display
958	Incorrect Display
959	Fails to Transfer to Redundant Equipment
961	High Anode Current
962	Low Power (Electronic)
964	Poor Spectrum
966	RF Window Suck-In, Broken or Cracked
969	Cannot Resonate Input Cavity
970	Coolant Leak
972	Damaged Input Probe
973	Damaged Output Probe
974	Does Not Track Tuning Curve

MALFUNCTION CODE	
982	Frozen Tuning Mechanism
985	High Body Current/Beam Interruption
986	High Body Modular Inverse
987	Input Pulse Distortion
988	Loss of Vacuum
989	Low Coolant Flow Rate
990	No Focus Current
991	Out of Band Frequency
992	Output Pulse Distortion
993	RF Drive Improper
994	RF Feed-Through Attenuated/Distorted
995	RF Feed-Through Completely Interrupted

TABLE D-2 ACTION TAKEN CODES

Action Taken Codes 1 through 9 are restricted to those repairable items of material which have been administratively or technically screened and found to be not-repairable at an AIMD. (By designated intermediate level personnel authorized to make these determinations.) In keeping with the philosophy or repair at the lowest practicable level, the AIMD is authorized to perform any and all functions for which it has or can be granted authority and the capability to perform and meet performance specifications.

1. BCM -- Repair Not Authorized. This code is used when the activity concerned is not specifically authorized and cannot be authorized repair capability for an item.

2. BCM -- Lack of Authorized Equipment, Tools, or Facilities. This code is used when repair is authorized but cannot be performed because of a lack of authorized equipment, tools, or facilities.

3. BCM -- Lack of Technical Skills. This code is entered when repair exceeds skill capability of assigned personnel (see also 5).

4. BCM -- Lack of Parts. This code is entered when parts are not available locally or have not been reported as available and shipped to the requesting activity to accomplish repair within time limits established by exisiting directives.

5. BCM -- Shop Backlog. This code is entered whenever excessive shop backlog precludes repair within limits specified by current directives.

6. BCM -- Lack of Technical Data. This code is entered when repair cannot be accomplished due to lack of maintenance manuals, drawings, etc., which describe detailed repair procedures and requirements.

7. BCM -- Excess to Ship/Activity Requirements. This code is entered when items of material will not be scheduled for shop repair, due to being in excess of local requirements. This determination can only be made by the local supply officer and/or higher authority.

8. BCM -- Budgetary Limitations. This code is used when there are insufficient funds to expend or there are limited funds available which are reserved for repair of items of material considered to be of a more urgent priority.

9. Condemned. This code is entered when the item cannot be economically repaired and is to be processed for condemnation, reclamation or salvage.

All codes listed below may be used for both on or off equipment work unless otherwise noted.

A. Item of Repairable Material or Weapons/Support System Discrepancy Checked -- No Repair Required. This code is used for all discrepancies which are checked and found that either the reported deficiency cannot be duplicated, or the equipment is operating within allowable tolerances. Adjustments may be made under this code if the purpose of the adjustment is to peak or optimize performance. When adjustments are made, the malfunction code should reflect the reason for the adjustment (e.g., A-127, A-281, A-282, etc.). If the purpose of the adjustment is to bring the equipment within allowable tolerances, Action Taken Code C should be used (e.g., C-127, C-281, C-282, etc.).

8. BCM -- Budgetary Limitations. This code is used when there are insufficient funds to expend or there are limited funds available which are reserved for repair of items of material considered to be of a more urgent priority.

Source: OPNAVINST 4790.2A, Volume II
Change 6, 20 September 1976,
Appendix G, pp. G1 - G3.

TABLE D-2 ACTION TAKEN CODES (CONTINUED).

B. Repair and/or Replacement of Attaching Units, Seals, Gaskets, Packing, Electrical Connections, Wiring, Circuits, Tubing, Hose, Connectors, Fittings, etc., that are not an integral part of Work Unit Coded items or components as purchased from the Manufacturer and held in the supply system in an RFI status. These units are not identified by work unit codes and are normally a connecting link in a weapons/support system between two or more components that do have WUCs assigned. Therefore, when items of this nature are repaired or replaced, this action taken code is used. In case of doubt regarding which component to identify in the WUC block, the WUC of the component serviced will be used. (Example: If a cannon plug to the landing gear actuator does not have a work unit code, the code for the landing gear actuator will be entered.)

C. Repair. This code is entered when a repairable item of material which is identified by WUC is repaired. Repair includes cleaning, disassembly, inspection, reassembly, lubrication, and replacement of integral parts; adjustments are included in this definition if the purpose of the adjustment is to bring the equipment within allowable tolerances. (See also Action Taken Code A.) This code also applies to the correction of a discrepancy on a weapons/support system, when appropriate.

D. Work Stoppage -- Fost/Predeployment. This code is entered to close out VIDS/MAF copy 1 when component reoair is interrupted upon completion of a deployment and repair is to be performed at another facility. (See NOTE, page G-3.)

E. Local Manufacture. This code is used to document the lccal manufacture of missile target repair parts, special equipment, and peculiar support equipment. (For use in missile and missile target activities only.)

J. Calibrated – No Adjustment Required. This code is used when an item is calibrated and found serviceable without need for ajustment. If the item requires adjustment to meet calibration standards, use code K. (The code applies to PME only.) (See Note, page G-3.)

K. Calibrated Adjustment Required. This code is used when an item must be adjusted to meet calibration standards. If the item needs repair in addition to calibration and adjustment, use another code indicating the proper maintenance action. (This code applies to PME only.) (See Note, page G-3.)

L. Work Stoppage – Awaiting Parts. This code is entered when a maintenance action must be stopped or delayed while awaiting parts which are not available locally, and a component goes into an awaiting parts status. (Use of this code is restricted to the intermediate level only or authorized SX activities.)

N. Work In Progress Close Out. This code is entered by an organizational acitivity when it becomes necessary to close out a maintenance action during, or at the end of a reporting period for any reason. This code will be entered by an intermediate maintenance activity to close out for any reason except awaiting parts. (See Action Taken Code L).

Codes P through S are used for on equipment maintenance only.

P. Removed. This code is entered when an item of material is removed and only the removal is to be accounted for. In this instance delayed or additional actions are accounted for separately. (See also R. S. & T.)

TABLE D–2 ACTION TAKEN CODES (CONTINUED)

Q. Installed. This code is entered when an item is installed and only the installation action is to be accounted for. (See also U.)

R. Remove and Replace. This code is entered when an item of material is removed due to a suspected malfunction and the same or a like item is reinstalled. (See also codes T and U, and NOTE on page G-3.)

S. Remove and Reinstall. This code is entered when an item of material is removed to facilitate other maintenance and the same item is reinstalled. Action Taken Code S is limited to Malfunction Codes 800, 801, and 804. (See also Codes T and U.)

T. Removed for Cannibalization. This code is used when an item of material is cannibalized.

U. Replaced after Cannibalization. This code is entered when an item of material is replaced after cannibalization.

Y. Troubleshoot. This code is used when the time expended in locating a discrepancy is great enough to warrant separating the troubleshoot time from the repair time. Use of this code necessitates completion of two separate documents, one for the troubleshoot phase and one for the repair phase. When recording the troubleshoot time separate from the repair time, the total time taken to isolate the primary cause of the discrepancy is recorded on a separate VIDS/MAF, using the system sub-system or assembly WUC as appropriate.

Z. Corrosion Treatment. Includes cleaning, treating, priming and painting of corroded items that require no other repair. This code is always used when actually treating corroded items, either on equipment or in the shop. Use support action form and applicable code when reporting painting or corrosion preventive treatment.

0. The numeric 0 will be used in the action taken block on all source documents recording look phase man-hours for Acceptance/Transfer. Conditional and Calendar inspection including the close out of man-hours on the look phase of those inspections at the end of the reporting period.

NOTE

The Action Taken Codes D, J, and K are used only when the transaction code in block A32 of the VIDS/MAF is 31 or 32. Action Taken Code E may be used only by missile and missile target activities to document the local manufacture of repair parts. Action Taken Code R may be used when the transaction code in block A32 of the VIDS/MAF is 11, 18, 19, 23, or 25. The use of action taken code "R" with transaction codes 18 and 19 should only be used for Work Unit coded consumable items which are time sensitive and/or require entries in log books/AESRs such as spark plugs, CAD cartridges etc. The use of Action Taken Code R may also be used with transaction code 11 by an assisting Work Center when the action taken code R is used by the primary Work Center.

APPENDIX E

FACTORS THAT EFFECT MAINTENANCE MANHOUR PER FLIGHT HOUR (MMH/FH)

1. INTRODUCTION

The term MMH/FH is used extensively in maintainability analysis to depict the maintenance requirements of a weapon system. Certain characteristics of this parameter make it necessary to explore some of the variables which effect its behavior.

Variables which can be measured and quantified were selected for analysis. They include: failure rate (Mean Flight Hours Between Failures - MFHBF), aircraft utilization rate, time and design characteristics. The relationship between these variables and MMH/FH is shown in Figure E-1 and discussed in this section.

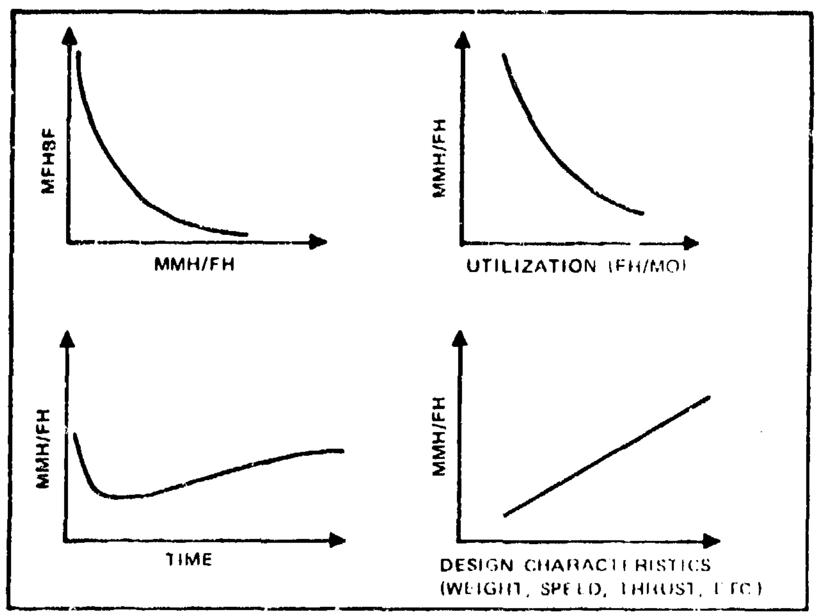

Figure E-1 Factors Effecting MMH/FH

In summary: (1) MMH/FH is inversely proportional to MFHBF and aircraft utilization. Higher MFHBF's and greater aircraft utilization result in lower MMH/FH expenditures. (2) MMH/FH is not a constant for a given aircraft but instead varies with time. During the useful life of a weapon system, a decreasing MMH/FH trend early in the operational phase reverses to a steadily increasing trend because of equipment wear out. (3) MMH/FH is directly proportional to aircraft design and performance characteristics. Inherently, heavier aircraft with higher speeds and greater thrust require more maintenance.

2. MMH/FH Versus MFHBF

It is recognized that MFHBF drives MMH/FH, but what is not well known is the numerical relationship between the two parameters. Figure E-2 shows the inverse relationship between these parameters where lower values of MFHBF (higher failure rates) result in increased maintenance expenditures to restore the weapon system.

Figure E-2 was derived from data presented in the Fleet Weapon System Reliability and Maintainability Statistical Summary Tabulation (RAMS) (Reference 9). A six year time period was used to eliminate any time trend variations. Cumulative average values were plotted for the Fighter/Attack/ASW aircraft used in this Handbook along with selected helicopter and trainer aircraft to yield a better distribution of the data. As can be seen, the more complex and heavier aircraft exhibit higher MMH/FH values (lower MFHBF'S) while the simple, lightweight aircraft exhibit much lower MMH/FH values (higher MFHBF'S).

The next generation of complex aircraft will require significant improvements in M by several orders of magnitude if they are to achieve values comparable to present day helicopters/trainers. Either that, or another definition of "failure" is needed to differentiate between real world and a demonstration environment. This would amount to developing a second curve slightly above the present.

3. MMH/FH Versus UTILIZATION RATE

A second factor effecting MMH/FH is aircraft utilization rate. Studies have shown that MMH/FH decreases as sortie length increases (Reference 16 and 17). Similarly, this also holds true for monthly utilization expressed in flight hours per month. In this case, sortie length remains essentially the same, but flights per month increase. A typical increase trend is shown in Figure E-3.

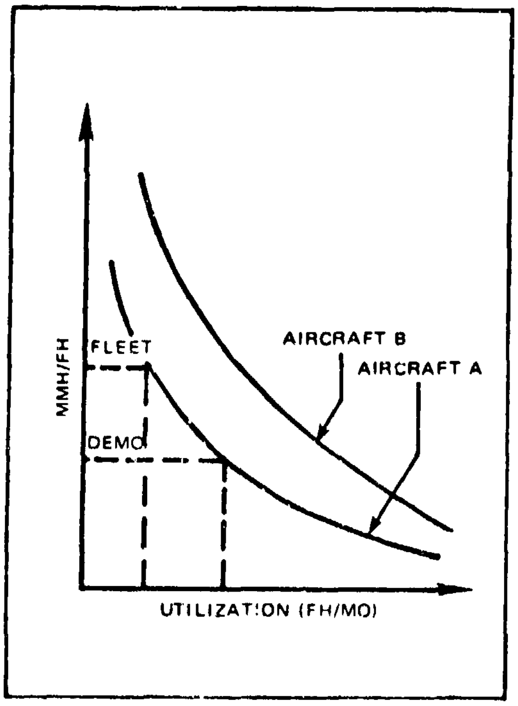

Figure E-3 Aircraft Utilization

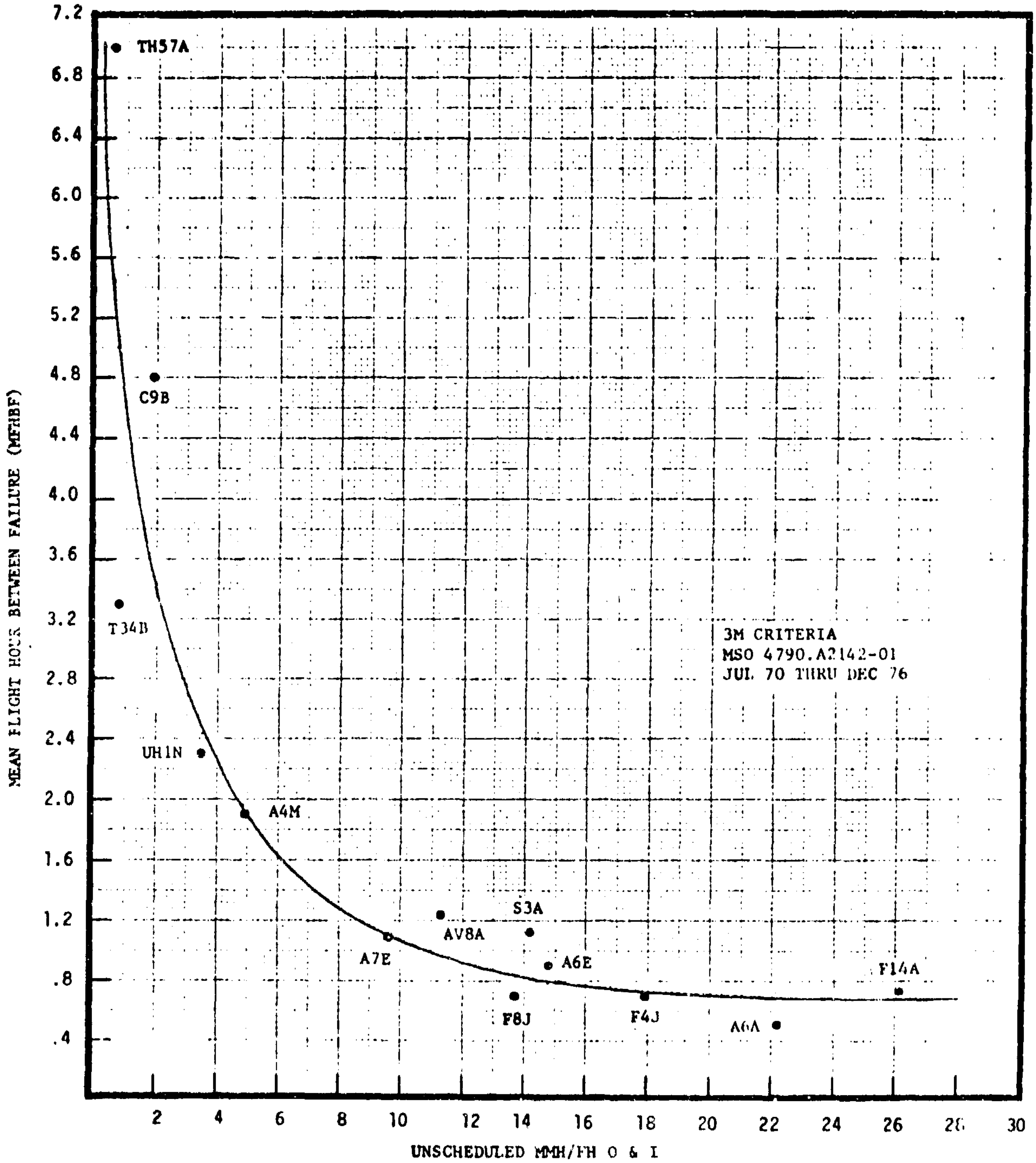

FIGURE E-2 UNSCHEDULED MMH/FH - VS - MFHBF

Reasons for this trend can be attributed to squadron operating policy, manpower and availability of spares. In addition a weapon system has shown to operate more efficiently in accelerated operating conditions than in normal routine flight operations. Manhours spent for additional servicing, inspections and unscheduled maintenance are off-set by more flight hours flown thus lowering MMH/FH.

The importance of this point becomes evident during the maintainability demonstration of a new weapon system. Under controlled, accelerated testing conditions, higher than normal utilization rates are experienced resulting in lower than normal MMH/FH values. When the aircraft eventually becomes operational, utilization decreases and MMH/FH increases.

Further study is required to determine the exact relationship between these two parameters to avoid controversy between fleet and demonstration data.

4. MMH/FH Versus TIME

A third factor effecting MMH/FH is time. Traditionally, the reliability "bathtub" curve is used to classify the life cycle of a weapon system into three phases: infant mortality, useful operating life and wear out, Figure E-4. Predictions are generally made for a mature aircraft on the flat part of the curve which is characterized by a constant failure rate.

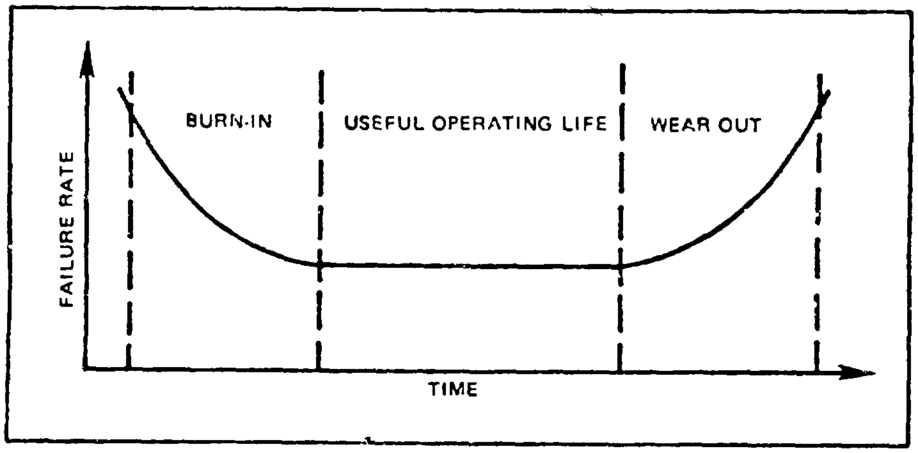

Figure E-4 Theoretical "Bathtub" Curve

Unfortunately, real world behavior is not so simple. Many factors enter into the problem with the net result that MMH/FH is not a constant for a given aircraft, but instead varies significantly with time. Figure E-5 shows a composite distribution of MMH/FH with time based on analysis of the nine aircraft used in this handbook over a six year period (Reference 9).

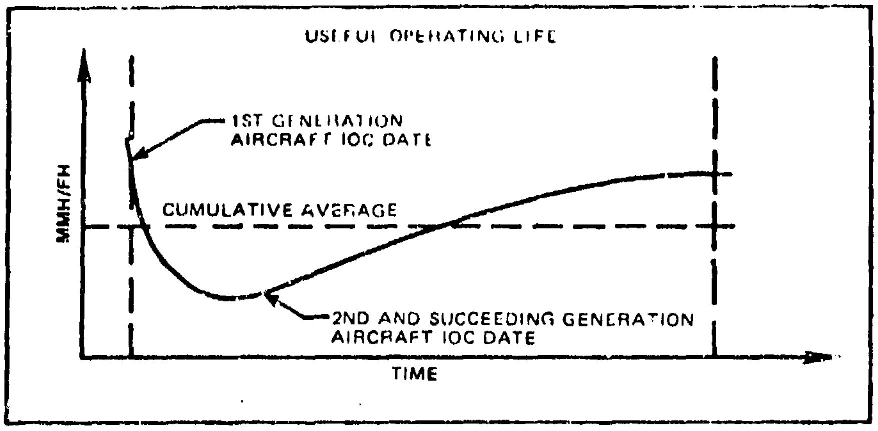

Figure E-5 Actual "Bathtub" Curve

Analysis shows that first generation aircraft (F-14A, S-3A) tend to follow a modified "bathtub" curve. Initially, MMH/FH data is high because of the usual new aircraft problems, i.e., training, spares deficiency, limited support equipment, etc., and then it dips to a low point a few years after Initial Operational Capability (IOC) is achieved. From this point on, aircraft maintenance problems and equipment wear out become the predominant driver of MMH/FH as it increases with time. Second and succeeding generations of aircraft (A-4M, F-4J, P-3C, etc.) start off at the low point in the curve and continue to increase. These aircraft normally do not exhibit the new aircraft problems to the degree their first generation predecessors did. Aircraft maintenance problems and equipment wear out are the primary reasons for the steady increase in MMH/FH. Sometimes this trend may level off four to six years after IOC.

Case histories depicting the exact relationship between MMH/FH and time are documented in Table E-1 and Figure E-6. The cumulative average MMH/FH of each aircraft over the given time period is also shown.

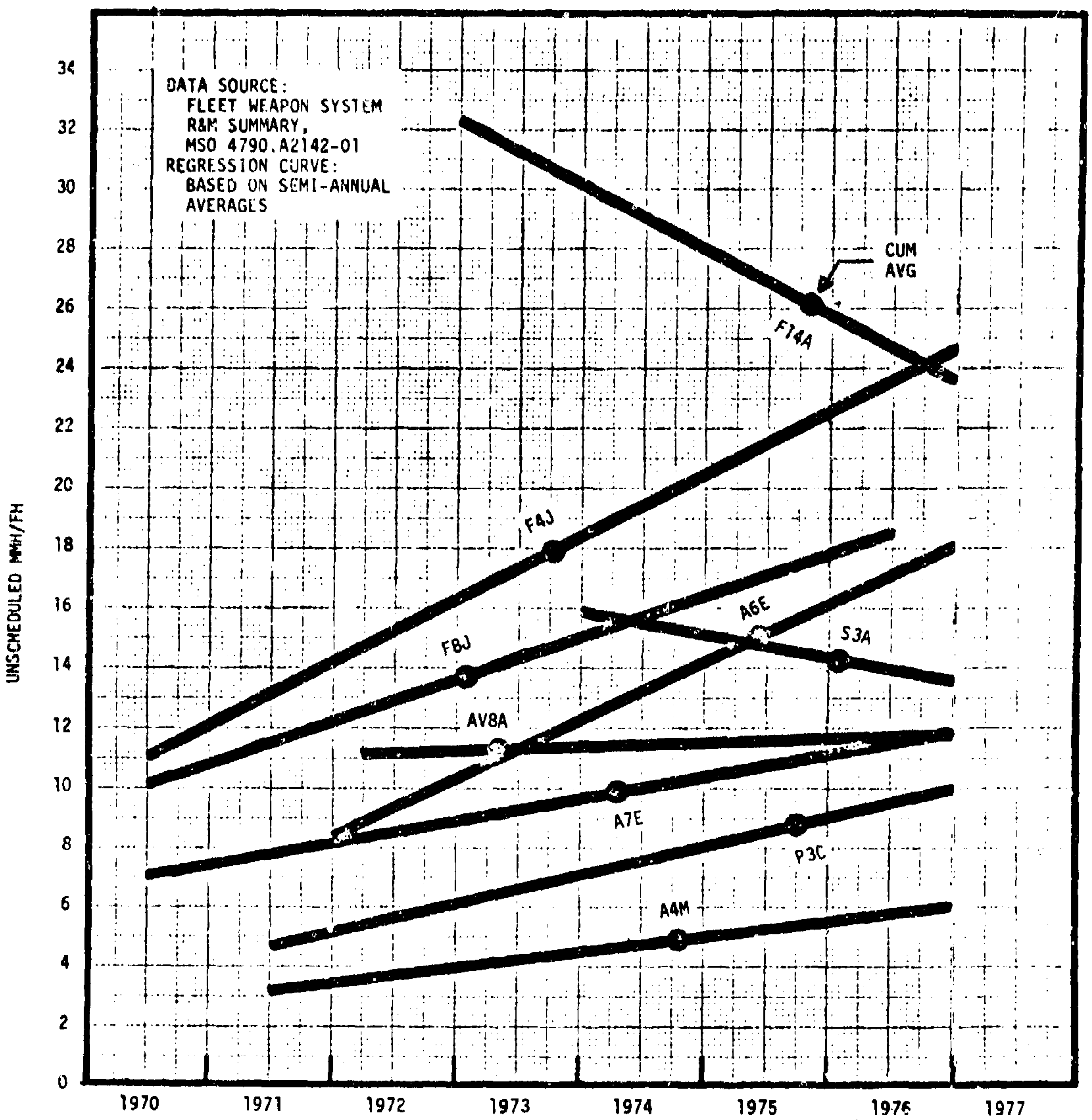

FIGURE E-6 NAVY AIRCRAFT UNSCHEDULED MMH/FH TRENDS

TABLE E-1 MMH/FH AS A FUNCTION OF TIME

TIME PERIOD	UNSCHEDULED MMH/FH – O&I								
	A-4M	A-6E	A-7E	AV-8A	F-4J	F-8J	F-14A	S-3A	P-3C
JUL 70 – DEC 70	–	–	5.74	–	10.87	10.16	–	–	5.54
JAN 71 – JUN 71	–	–	–	–	–	–	–	–	–
JUL 71 – DEC 71	3.24	4.87	8.21	–	13.27	11.81	–	–	5.66
JAN 72 – JUN 72	3.55	7.25	9.40	11.38	14.09	11.94	–	–	5.86
JUL 72 – DEC 72	3.43	12.42	8.30	12.74	15.24	15.45	–	–	5.52
JAN 73 – JUN 73	4.72	13.12	9.14	11.97	17.30	11.37	33.66	–	6.24
JUL 73 – DEC 73	4.99	13.28	10.53	10.59	19.47	16.67	36.17	–	6.47
JAN 74 – JUN 74	4.52	14.07	11.14	9.98	21.37	14.39	24.76	15.10	7.23
JUL 74 – DEC 74	4.62	12.79	10.34	11.09	20.78	18.00	20.54	15.21	7.34
JAN 75 – JUN 75	5.65	14.48	9.65	11.73	20.69	15.26	31.45	16.13	7.61
JUL 75 – DEC 75	4.72	14.79	10.67	10.32	20.61	17.27	24.77	14.74	8.15
JAN 76 – JUN 76	5.75	14.74	10.84	10.19	21.49	–	27.12	13.00	10.37
JUL 76 – DEC 76	6.10	18.10	11.51	14.80	24.11	–	25.63	14.03	10.44
CUM AVG	4.92	14.83	9.58	11.34	17.93	13.69	26.14	14.22	7.63
	FLIGHT HOURS								
JUL 70 – DEC 70	–	–	37,836	–	52,694	12,745	–	–	10,431
JAN 71 – JUN 71	–	–	–	–	–	–	–	–	–
JUL 71 – DEC 71	4,140	87	34,824	–	42,019	9,815	–	–	17,649
JAN 72 – JUN 72	3,894	1,335	39,454	1,185	54,474	12,435	–	–	22,242
JUL 72 – DEC 72	6,644	2,807	37,137	1,688	42,351	9,449	–	–	25,949
JAN 73 – JUN 73	7,292	4,699	44,652	3,231	46,562	10,783	704	–	30,075
JUL 73 – DEC 73	6,897	9,072	44,396	4,188	42,175	8,174	2,375	–	31,881
JAN 74 – JUN 74	7,565	13,685	41,861	5,406	45,171	7,581	6,375	1,633	34,816
JUL 74 – DEC 74	8,000	18,511	45,584	5,000	38,219	6,523	9,886	5,179	36,997
JAN 75 – JUN 75	7,623	23,087	55,651	7,217	43,325	7,194	9,178	8,013	41,856
JUL 75 – DEC 75	11,273	27,688	49,172	6,801	41,027	4,600	14,532	14,[illegible]49	42,507
JAN 76 – JUN 76	10,247	29,500	54,502	6,972	37,130	–	16,995	20,565	37,985
JUL 76 – DEC 76	14,051	30,376	55,937	5,623	36,913	–	19,759	2[illegible],462	45,368

DATA SOURCE: FLEET WEAPON SYSTEM R&M STATISTICAL SUMMARY (REF. 9)

5. MMH/FH Versus DESIGN

The fourth and most important factor effecting MMH/FH is aircraft design. Time and utilization rate effect MMH/FH because of operating conditions while physical size, complexity and M considerations effect MMH/FH through design. Inherently, heavier aircraft with higher speeds and greater thrust require more maintenance. To reverse this trend, greater emphasis is placed on M.

Figure E-7 shows the technique used in this Handbook to determine aircraft maintenance requirements. Baseline MMH/FH is determined by the Maintainability

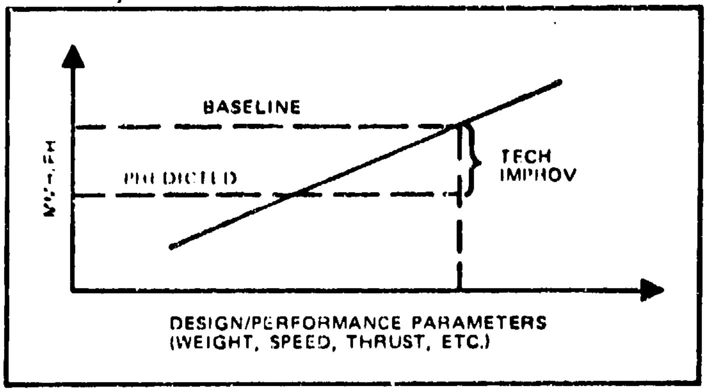

Figure E-7 MMH/FH As a Function of Design

Index Model discussed in Section 3.0. The model yields the minimum acceptable MMH/FH expected for a given weapon system using existing state-of-the-art technology and average M effort. Predicted MMH/FH is determined from contractor estimates for the new design. Stringent Navy requirements plus advances in technology and correction of past maintenance problems necessitate the contractor predict lower MMH/FH estimates than the baseline model shows.

LIST OF ABBREVIATIONS AND ACRONYMS

ASMRA	Adjustment of Scheduled Maintenance Requirements through Analysis
ASW	Anti-Submarine Warfare
BIT	Built-In-Test
BITE	Built-In-Test-Equipment
BMMH/FH	Baseline Maintenance Manhours per Flight Hour
CCUMS	Contractor Controllable Unscheduled Maintenance Summary
CIC	Cross Index Code
CLASS 1	Customer Reported Gross Maintenance
CLASS 2	Contractor Responsible Basic Maintenance
CLASS 3	Contractor Controllable Design Maintenance
CNI	Communication/Navigation/IFF Package
CREW	Crew Size
CRUMS	Contractor Responsible Unscheduled Maintenance Summary
CT	Card Type
DIM	Design Induced Malfunctions
DTC	Design-To-Cost
ECA	Equipment Condition Analysis
ECIP	Equipment Cross Index Program
ECS	Environmental Control System
EMT/MA	Elapsed Maintenance Time per Maintenance Action
ENGQTY	Number of Engines
ER	Evaluation Record
FI	Frequency Index
FIDR	Frequency Index Defect Ratio
FIIR	Frequency Index Intermediate Level Ratio
FMSO	Fleet Maintenance Support Office

LIST OF ABBREVIATIONS AND ACRONYMS (Continued)

FOD	Foreign Object Damage
FRUMS	Fleet Reported Unscheduled Maintenance Summary
FSE	Fleet Supportability Evaluation
FUEL	Internal Fuel Capacity
FUSLEN	Fuselage Length
GENKVA	Generator Electrical Power
GFE	Government Furnished Equipment
I	Intermediate Level Maintenance
IOC	Initial Operational Capability
ILR	Intermediate Level Ratio
IR	Infrared
JCN	Job Control Number
KAPU	Auxiliary Power Unit Factor
KBLC	Boundary Layer Control Factor
KCHUTE	Drag Chute Factor
KE	Kinetic Energy (WTLAND x VMIN^2)
KGUN	Gun Factor
KWING	Wing Sweep Factor
LCC	Life Cycle Cost
M	Maintainability
MADF	Maintainability Analysis Data Form
MAF	Maintenance Action Form
MA/FH	Maintenance Action per Flight Hour
MDR	Maintenance Data Reporting
MEN/MA	Men per Maintenance Action
MFHBF	Mean Flight Hour Between Failure
MFHBMA	Mean Flight Hour Between Maintenance Action

LIST OF ABBREVIATIONS AND ACRONYMS (Continued)

MI	Maintenance Index
MIDR	Maintenance Index Defect Ratio
MIIR	Maintenance Index Intermediate Level Ratio
MIM	Maintainability Index Model
ML	Maintenance Level
MMH/MA	Maintenance Manhour per Maintenance Action
MMH/FH	Maintenance Manhour per Flight Hour
MR	Manning Ratio
MSO	Maintenance Support Office
MSOD	Maintenance Support Office Department
MTTR	Mean Time To Repair
N/A	Not Applicable or Available
NAILSC	Naval Aviation Integrated Logistics Support Center
O	Organizational Level Maintenance
O+I MTBF	Organizational plus Intermediate Maintenance Level Mean Time Between Failure
OIM	Operational Induced Malfunctions
PGSE	Peculiar Ground Support Equipment
PMMH/FH	Predicted Maintenance Manhours per Flight Hour
PYLQTY	Number of Pylons
R+R	Remove and Replace Time
r	Correlation Coefficient
RAMS	Fleet Weapon System Reliability and Maintainability Statistical Summary
S	Standard Error of Estimate
2S	Confidence Level, 95%
SAC	Standard Aircraft Characteristics

LIST OF ABBREVIATIONS AND ACRONYMS (Continued)

SAF	Support Action Form
SCHED	Scheduled Maintenance Summary
SWUC	Standard Work Unit Code
TI	Technology Improvement Index
THRUST	Thrust per Engine
VIDS	Visual Information Display System
VMAX	Maximum Speed at Altitude
VMIN	Minimum Carrier Approach Speed
WAREA	Wing Area
WRA	Weapons Replaceable Assembly
WTAVIN	Avionics Installed Weight
WTAVUN	Avionics Uninstalled Weight
WTCOM	Combat Weight
WTGUN	Gun Weight
WTLAND	Clean landing Weight
WTMT	Empty Weight
WTMXTO	Maximum Take-off Weight
WUC	Work Unit Code
3-M	Maintenance, Management and Material System